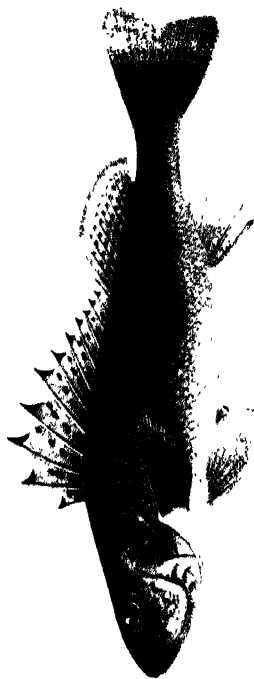


THE WAYSIDE
AND WOODLAND
SERIES

THE FISHES
OF
THE BRITISH ISLES



Perch. ♂ B.
Ruffe. ♂ H.

THE FISHES
OF
THE BRITISH ISLES
BOTH
FRESH WATER AND SALT

BY
J. TRAVIS JENKINS, D.Sc., Ph.D.
AUTHOR OF
"THE SEA FISHERIES," "A HISTORY OF THE WHALE FISHERIES,"
"A TEXT-BOOK OF OCEANOGRAPHY"

WITH 299 ILLUSTRATIONS
128 OF WHICH ARE IN FULL COLOUR

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PREFACE

THERE is no modern book which deals with British Fish as a whole. For fresh-water fish generally there are several, the best being that by Tate Regan (1911). There are also books on special fish or families of fish, of which those on the Salmon by Calderwood, Hutton, Malloch and Dahl may be mentioned. But for the naturalist who requires a guide to British Fish as a whole there is nothing but the ponderous volumes of Day (1880-84), or Fries, Ekström and Sundevall's "History of Scandinavian Fishes," 1893. Both these works are bulky, scarce and expensive, and, in addition, Day in particular is hopelessly out of date. Consequently the author feels that no apology is needed for the publication of a Handy Pocket Volume dealing with the characteristics and habits of British Fish, both fresh water and salt. For the student who wishes to study the subject in greater detail than is possible here, a list of the more important works of reference is appended (Bibliography, p. 393).

Of recent years much research has been directed to the investigation of the structure, habits, relationships and life-histories of our fish, both those which are commercially valuable, and those which are not. The results of these researches are, however, hidden away in publications which are not accessible to the general public, and even were they more accessible the cost of obtaining a fairly complete or representative collection would be prohibitive, and, moreover, many of these papers are published in the German and French languages.

Considerable strides forward have been made in the investigation of fresh-water fish, but in the case of salt-water species the advance in our knowledge is even more marked, and it would be quite correct to say that all our accurate knowledge

of the habits and life-histories of marine fish has been obtained since the publication of Day's work.

The enormous development of our sea fisheries which took place in the late 'eighties and early 'nineties of the last century led to great interest being taken in the habits and reproduction of sea fish, more especially as the rapid development of steam trawling gave rise to complaints about overfishing, a question which obviously could only be settled provided an accurate knowledge of the life-histories of the fishes concerned was obtained.

Simultaneously with the development of our sea fisheries, scientific men devoted their attention more and more closely to the study of marine biology, and especially of fish-life (p. 30).

I am indebted to several friends for permission to reproduce photographs, drawings and prints illustrative of British fish and their life-histories. The coloured illustrations on Plates 1, 7, 60, 90, 92, 93, 94, 95, 96, 97, 98, 99, 104, 104, 108, 110, 111, 113, 114, 115, 116, 119, 120, 123, 124, 126, 136, are from Grote, Vogt and Hofer's book on the "Fresh-Water Fishes of Central Europe"; those on Plates 3, 4, 8, 10, 18, 22, 25, 34, 36, 39, 41, 42, 49, 50, 59, 83, 85, 129, 131, 134, 143, from "A History of Scandinavian Fishes," by Prof. F. A. Smitt. The mackerel (Plate 21) and Wrasses (Plate 52) are from Ainsworth-Davis's "Natural History of Animals" (Messrs. Blackie & Son, Ltd.).

For permission to reproduce coloured illustrations of especial interest, I am indebted to Dr. E. J. Allen and the Council of the Marine Biological Association for the figures of the various species of Sole (Plates 76, 79, 80), taken from Cunningham's work on the Common Sole; to Professor Heincke for coloured illustrations (Plate 109) of the herring from his valuable work on the "Natural History of the Herring"; to the Irish National Fishery Board for permission to reproduce the coloured illustrations (Plates 29, 30) from Mr. Holt's paper on Gobies; to Messrs. Høst & Son of Copenhagen, and the International Council, for the coloured figures of the mature and immature plaice (Plate 65). The coloured illustration of the Gurnards (Plate 17) is from Messrs. Warne's "Royal Natural History."

Of the uncoloured representations of fish, Plates 2, 5, 6, 9, 12, 13, 15, 16, 19, 20, 24, 26, 27, 28, 31, 32, 33, 38, 40, 44, 45, 46, 47, 51, 54, 56, 58, 61, 62, 63, 64, 69, 70, 71, 72, 74, 75, 77, 78, 81, 82, 84, 86, 102, 105, 117, 118, 121, 122, 123, 127, 128, 130, 132, 135, 137, 138, 139, 140, 141, are from "Fishes of Great Britain and Ireland," by Francis Day, F.L.S., F.Z.S., etc.; Plate 142 from Dean's "Chimæroid Fishes;" and Plates 23, 26 from Holt's paper.

For the illustrations depicting the life-history of fish, I am especially indebted to Mr. J. Arthur Hutton for those of the Salmon (Plates 87, 88, 89, 91, 101); to Professor Meek for Plates 11 and 43; to Dr. Francis Ward for those on Plate 66; to Mr. R. S. Clark for the egg capsule of the Thornback Ray (Plate 14); to Prof. Ehrenbaum for Plates 35, 37, 48, 53, as well as the eggs of Armed Bullhead (Plate 14), and Lesser Sand-eel (Plate 73); to Mr. Scott for Plates 67, 68, 106 (eggs of herring); and to Prof. Johnstone for Plate 73.

In conclusion, I am obliged to the late Mr. R. B. Marston, Editor of the *Fishing Gazette*, for permission to reproduce information as to records of the largest individuals of certain freshwater fish caught by fair angling in the British Isles.

PREFACE TO SECOND EDITION

THIS second edition marks a considerable advance in the number of fish regarded as British. In the first edition the 100 fathom line was taken as the British limit; but now the list prepared by Mr. Norman for the Association of British Zoologists has been used. This list has been substituted for that which appeared in the first edition (pp. 351-361). It gives me great pleasure to acknowledge the friendly assistance received from many experts. In a quite especial degree I am indebted to Mr. J. R. Norman, Assistant Keeper in the Department of Zoology (Fishes) of the British Museum (Natural History).

For Scottish records I wish to express my thanks to Dr. R. S. Clark, Scientific Superintendent to the Scottish Fishery Board;

to Mr. A. C. Stephen of the Royal Scottish Museum, Edinburgh, and to Mr. R. Gregory Absalom, the Curator of the Natural History Department of the Glasgow Art Galleries and Museums.

Since most of the new additions to the British fish fauna were taken on the Irish Atlantic Slope I am greatly indebted for information supplied by Dr. G. P. Farran of the Department of Lands and Fisheries, Dublin, and to Dr. O'Connor, Keeper in the Natural History Division of the *Ard Mhusaeum Na h'Eireann* (National Museum of Ireland), Baile Atha Cliath (Dublin), Irish Free State.

For Welsh records I have to thank Mr. Colin Matheson, Keeper of the Department of Zoology in the National Museum of Wales, Cardiff. One criticism of the first edition was that I had not sufficiently emphasised the importance of the work in the North Sea carried out by the scientists concerned in the British share of the International Investigations. If this be correct, I regret it.

The work of the following scientists was referred to by name : for England, Drs. Russell, Wallace and Buchanan-Wollaston ; for Scotland, Fulton, D'Arcy Thompson, Clark and Williamson. The statistics for fish landed in Great Britain are omitted in this edition. They may be found in the Annual Reports of the Ministry of Agriculture and Fisheries and the Scottish Fishery Board.

I hope it is quite clear that while the older scientific names are retained in the text in this edition, the new names are given in the List printed on pp. 376-392. After very careful consideration this seems to be the most satisfactory way of dealing with a period of transition. For the new illustrations my thanks are due to the Department of Lands and Fisheries, Ireland (Figs. 2, 9, 12, 17, 21), the Marine Biological Association of the United Kingdom (Fig. 5), the Smithsonian Institution of the United States of America (Figs. 1, 3, 4, 6-8, 10, 11, 13-16, 18, 19) and the Zoological Society of London (Fig. 20).

THE FISHES OF THE BRITISH ISLES

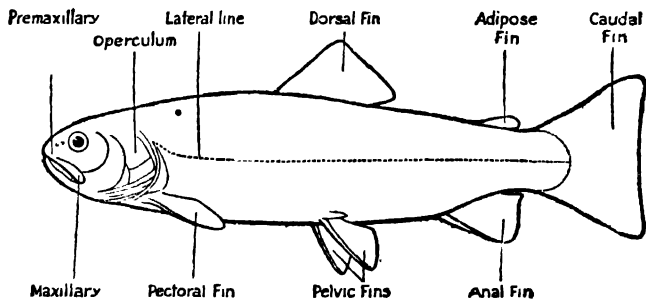


INTRODUCTION.

NO attempt is made in this book to give an account of the comparative anatomy of fish. But since all observation on the habits of fish and all study of the subject must be based on the correct identification of the species concerned, in every case sufficient information is given to enable a careful observer to identify an adult fish. Indeed, this is not difficult in the vast majority of cases ; though in certain species which do not attain a large size, such as the Gobies, the beginner will meet with some difficulty at first.

The golden rule is to work from the known to the unknown. Nearly every one knows some species of fish by sight, even though the scientific names are not familiar. The student of fish-life, therefore, should commence with noticing the external characters of known species, carefully observing the points which are important for purpose of identification. After a certain familiarity in the use of the terms employed in classification has been obtained, the identification of strange forms will not be a difficult matter. It is when we deal with the immature or young forms that we meet with greater obstacles ; for instance, in distinguishing a herring from a sprat of the same size, or a young sole from a solenette, a certain amount of care and discrimination must be exercised. Again, the distinguishing of varieties of certain freshwater forms such as the

Salmonoids is not a matter that can be learnt in a day, but if the angler, sportsman, or lover of nature will bear in mind the rule stated above he will only occasionally be baffled, and then he should have recourse to either a specialist or some collection of fish. The illustrations of the various species in this book should be carefully studied, as they will afford much assistance in identification. Technical terms have as far as possible been avoided, and features which are only observable on dissection of the fish are not generally referred to.



EXTERNAL FEATURES OF A FISH.

In order to identify a fish correctly, some knowledge of the terms used in describing the external character of fish is absolutely necessary. A brief description, applicable more particularly to British fish, is therefore given here.

The appearance of a typical fish, such as the Herring or Salmon, is so well known as to need no description. There is even amongst British fish a wide variation from the typical "fish-like" body. Four parts are usually distinguished, the head, trunk, tail and fins. The boundary between the head and trunk is determined by the gill opening, and between trunk and tail by the vent.

The body of a fish may be much elongated, as in the Eel or Ling ; or truncated, as in the Sun-fish.

In fish which live at the bottom of the sea the body may be flattened. This flattening may be either vertical, from above downwards, as in the Rays and Skates ; or lateral, from side to side, as in the Plaice and Sole.

In the latter case both eyes are on the same side of the head, either on the right side, as in the Halibut, Long Rough Dab, Plaice, Lemon Sole, Witch, Flounder, Dab and the various species of Sole ; or on the left side, as in the Turbot, Brill, Scald-fish and Megrim. In these fish the side of the body on which the eyes are found is coloured ; the other side, on which the fish rests when on the bottom, is colourless. Occasionally specimens are met with in which the under-surface is wholly or partially coloured. It is most exceptional to find a variation in the side on which the eyes are present, *i.e.* a sole or plaice with the eyes on the left side is a great rarity ; certainly not one in a hundred thousand is so "reversed." Patterson records a sole from Yarmouth with the eyes on the left side (1904). In the Flounder, reversed specimens are not uncommon ; but it is only in the primitive members of the flat-fish family, such as the Indian Flat-fish (*Psettodes*), in which one meets with right or left-handed specimens indiscriminately.

So far as food is concerned fish are either predatory, plankton feeders (*i.e.* living on the minute organisms found floating or drifting in water) or vegetable feeders. Apart from the Lampreys, which are a very special group of fish, the mouth is provided with jaws. The mouth may be terminal, the usual case ; or ventral in position, as in the Barbel and Bream ; or through a prolongation of the lower jaw it may point upwards, as in the Angler and Weevers. Sometimes the jaws are prolonged, as in the Gar-fish. Predatory fish have a large mouth, as in the Pike and Trout ; non-predatory fish, on the contrary, a small one, as in the Carp. As stated below, fish have no

those of the smallest, the Common Sole, measure 12 by 9 μ . The number present in a given volume of blood varies with the size. In a cubic millimetre there are in Torpedo 0'14 million, in the Sole 2'00 million. There are also present in the blood of fish white amœboid corpuscles. The quantity of blood in fish is, as a rule, small and bears only a small relation (about one sixty-third) to the body weight. In the great majority of fish the temperature of the blood is exactly that of the surrounding water, but in a few fish, such as the Cod and Ling, there is a difference of a degree Centigrade between the blood (which is higher) and the surrounding water. In rapidly swimming fish, such as the Tunny, there may at times be a considerable difference. Freshly caught Tunny have been found to register a body temperature 10 degrees higher than the water.

Respiration in fish is accomplished by means of gills. There is very great variation in the structure of the gills and gill coverings of fish. In some bony fishes the structure and appearance of the bones covering the gill-region are of importance in classification. In many fish the gill cover is composed of four separate bones, of which the chief is the *operculum*; in the Perch, a triangular bone. In front of the operculum is the pre-operculum, usually a semicircular bone belonging rather to the suspensory bones of the mandible or lower jaw than to the opercles proper. This *pre-operculum* is a surface bone, frequently armed with spines of various kinds; its appearance and form make it an important item in differentiating closely allied species. In addition to the operculum which forms the posterior margin of the gill cover there are two bones below, forming the inferior margin of the gill cover. These are the *inter-operculum*, in front of and below the operculum, and the *sub-operculum*, immediately below the operculum and behind the inter-operculum.

These bones can sometimes be distinguished beneath the skin; at other times they are hidden by a thick skin and cannot

be distinguished without dissection. The terms are so frequently used in works on the classification of fish that a knowledge of their position is necessary.

These opercular bones are of course not present in cartilaginous fish, such as Skates and Sharks. The gill-opening in bony fish is a slit behind the head through which the water that has been taken in through the mouth passes out of the fish's body. In Rays and Skates there are five gill slits; in some Sharks there may be six or seven.

It is impossible to consider the variation in the structure of the gills and their supporting branchial arches; for information as to details of this and other internal organs of fish a work on comparative anatomy of fish should be consulted. Generally speaking, most Teleosteans (bony fishes) possess four complete gills. The gills are highly vascular structures, there is an arrangement for the circulation of the blood over the branchial lamellæ during which the blood is aerated. In many Teleosteans the gill arches are provided on their inner and front edges with a series of horny protuberances, the *gill-rakers*, which act as a sieve for the water passing over the gills. The solid substances in the water, such as small crustacea, larvæ of various invertebrates and so on, are retained by the gill-rakers, and being swallowed by the fish serve as its food. The quantity of oxygen utilised by fish is far less than that required by higher vertebrates. Some active fish, such as the Salmonidæ, only live in well-oxygenated water; other passive fish, such as the Carp, will live in water with much less oxygen. The Salmon requires from 7 to 8 cubic centimetres oxygen per litre; for the Cyprinoids, from 4 to 5 will suffice. Some fish are able to breathe in air when the oxygen supply in the water diminishes or fails, but this is an exceptional procedure (see p. 304). Most fish die speedily when withdrawn from the water owing to their gills drying up; but some fish, such as Eels which have a small gill opening, retain sufficient moisture in the gill cavity to enable

them to live out of the water for hours, or, if kept in a moist and cool place, even for days.

Fish exhibit great diversity in their breeding habits. In many fish there is an external difference between the sexes. The male exhibits secondary sexual differences when he commences to enter on his sexual functions. In British fishes these changes are seen in the Dragonet (*Callionymus*), the striped Wrasse (*Labrus mixtus*), in various Salmonidæ and in many Cyprinoids (Carp family). These secondary sexual characters may take the form of the prolongation of some of the fin rays, as in the Dragonet; or in a much brighter coloration, as in the Wrasse; or in the greater development of the jaw bones (Salmon) or in the excrescence of wart-like tubercles on the skin, as in the Carp family, where the first ray of the pectoral fin is also thickened. In most, if not in all, bony fish the female is larger than the male. In the Rabbit-fish or King of the Herrings (*Chimara*), the male possesses a singular comb-like cartilaginous structure on the top of the head, the function of which is unknown.

In the cartilaginous fishes, including the Rays, Skates, Dog-fish and Sharks, the male is distinguished from the female by the presence of claspers.

Few fish are viviparous, that is, giving birth to living young; for the most part they are oviparous, laying eggs which show great diversity in different species.

To the viviparous fish of the British Isles belong the Viviparous Blenny (*Zoarces viviparus*) and certain of the sharks, such as the Spiny Dog-fish (*Acanthias vulgaris*), the smooth Hound (*Mustelus*), the Porbeagle (*Lamna*), species of the true Shark (*Carcharias*) and the Norway Haddock (*Sebastes norvegicus*).

Fish eggs may conveniently be divided into those that float (pelagic) and those that sink (demersal). In some cases, however, a hard-and-fast line cannot be drawn, the eggs floating or sinking according to the density of the water.

Practically all freshwater fish lay demersal eggs, and these eggs are also met with in most estuarine spawners and those fish which lay eggs in moderate depths. The pelagic-egg producing species spawn offshore, sometimes in great depths. These eggs together with the milt of the male are shed on the spawning-ground, rising to the surface layers of water, there to undergo their development.

Pelagic eggs may be divided into two kinds. Those which are separate and those which are united together in a band or mass of gelatinous material. By far the greater number of pelagic eggs float free and separate in the sea; in the case of British species, the Angler (*Lophius piscatorius*) has its eggs in a band of jelly-like substance, and the Cat-fish (*Anarrhichas lupus*) has its eggs in a ball-like mass (Plate 43).

Fish are said to be *anadromous* when they migrate from the sea into fresh water to spawn; for instance, the Salmon, Shad and Sturgeon. Those which migrate from the rivers or fresh water to the sea to spawn are said to be *catadromous*: for example, the Eel. Practically all primitive fish which have survived to the present day are either confined to fresh water or are anadromous, and their eggs are demersal. Such fish are the Lampreys and the Sturgeon. The cartilaginous fishes, Sharks and Rays, have either demersal eggs or reproduce viviparously.

Demersal eggs may be provided with a horny protective covering or capsule, as in Dog-fish, Sharks and Rays; or may be adhesive, as in the Lumpsucker; or provided with organs of attachment, as in the Smelt and Hag-fish (*Myxine*). Most fish eggs, whether demersal or pelagic, are of small size and provided only with a thin protective membrane. The pelagic egg floats and drifts at the mercy of tides and currents, and is hence said to belong to the plankton (literally, drifters). The planktonic or pelagic eggs are for the most part minute rounded objects hardly distinguishable by the naked eye. They may be captured at the appropriate season of the year over the

spawning-bed by dragging a fine-meshed net of muslin or silk-bolting cloth (a tow-net) through the water. The differentiation of the floating eggs of our marine fish is a task that can only be undertaken by the specialist, points of importance being the size, shape, and presence or absence of oil globules inside the egg.

Demersal eggs may be laid singly or in pairs, as in the Dog-fish; or in a band or string, as in the Perch; or in a stream of separate eggs, as in the Herring or Sand-eel; or in masses of varying size or shape, as in the Lumpsucker or Seasuckers (*Lepadogaster*).

Parental care is exhibited by few fish. Amongst British species the Lumpsucker and Butter-fish (*Pholis gunnellus*) guard the eggs during development, the task being undertaken by the male.

A few fish build nests in which the eggs are laid; instances of this in British fishes are met with in the Sticklebacks (*Gasterosteus*) and Bullhead (*Cottus gobio*). The Salmon also prepares a place of protection for the eggs, though it can hardly be called a nest. In some fish the male carries the young about with him in a pouch of the skin, usually on the lower side of the tail; in British fish this may be seen in the Pipe-fish (*Syngnathus*).

Sea fish rarely or never form hybrids. I have examined many thousands of sea fish caught in the trawl during the last twenty years or so from near the Arctic regions to within the Tropics, and never have I seen a fish which could be considered a hybrid.

Amongst British freshwater fish hybrids are well known and have frequently been described by Tate Regan and others. In closely related species, such as the Roach and Rudd, these are not uncommon, and are in every way intermediate between the parent forms. Hybrids are also known between the Bream and Roach, and this is the more surprising since they belong to different groups of the Carp family. Hybridisation is,

however, rather too special a subject to be dealt with here ; reference should be made to Tate Regan, who has devoted considerable attention to this subject and is our foremost authority on it.

The chief hybrids are the Bleak and Chub, Bleak and Dace, Bleak and Roach, Bleak and Rudd, Bleak and White Bream, Bream and Roach, Bream and Ruddy Carp and Crucian Carp, Perch and Ruffe, Roach and Rudd, Salmon and Trout, White Bream and Roach, and White Bream and Rudd. It has been ascertained experimentally that the hybrids of the Salmon and Trout are of low vitality and are often mis-shapen. They seldom, if ever, come to maturity.

To understand the biology of fishes it is necessary to give some consideration to their sense-organs. The chief senses of fish are those of taste, touch, smell, sight, "hearing," and "sixth sense," if it may be so called, situated in the lateral line. It may at once be stated that the question of the significance of the various sensory organs of fish is by no means settled, and there are many differences of opinion as to the exact nature of their sense impressions. That they are in many respects different from land vertebrates goes without saying. The mere fact that fish live in a different medium from ourselves makes this certain, and one cannot be dogmatic about the reactions of fish to their environment.

In the first place, the organ of smell in fishes differs from our own in that it has no relation to the function of respiration. It is certain that fish have the faculty of smell, and they are attracted or repelled by certain odours.

The sense of taste in fish must be slight since the vast majority of fish swallow their food rapidly. The tongue may be absent altogether, and even when most developed is unprovided with those muscles which permit of the movements of extension and retraction seen in higher vertebrates. Taste-bulbs are found in the mouths of fish and on the palate, lips

and barbels. The Carps, which by means of their pharyngeal teeth can break up their food, are provided with a peculiar organ on the roof of the palate, which is perhaps an organ of taste, since it is richly provided with taste bulbs and nerves.

There is considerable diversity of opinion as to the significance of the olfactory organ in fish. Except in the Lampreys and Myxinoid fishes, the olfactory organ is a double sac, one on each side. This sac, which is lined with a folded membrane supplied by the olfactory nerve, does not communicate with the mouth. In some fish the nasal opening is single (Sharks) and provided with a valve or flap; in the majority of bony fish the nasal opening is double; the posterior is generally open, the anterior provided with a valve or tube. Naturally the circulation of water in the nasal organ is facilitated by a double opening to the exterior.

The position, direction and size of the eye in fishes vary enormously. In all fish the skin of the head passes over the eye, becoming transparent where it enters the orbit. The fish's eyeball is subhemispherical, the cornea being quite flat, and so when the fish swims it offers no resistance to the water, and being level with the head is not so liable to injury. The sight of a fish is much more limited than that of a land vertebrate. In the first place, even the clearest water is much less transparent than air, and in the sea and in standing water in lakes and ponds the water is always more or less cloudy, owing to the presence of particles in suspension and minute living organisms. In ordinary circumstances objects even a few yards away from a fish must either be invisible or appear hazy or of uncertain outline. Even in the clearest water it is doubtful whether a fish can see distinctly for more than 33 feet. Consequently it sees its prey only when near to it, and also to escape its enemies the fish only needs to make a short sharp dash for a few yards. If it were otherwise it would be impossible for small and defenceless fish to exist anywhere in the same neighbourhood

as larger and more predatory species. The structure of its eye shows clearly that as compared with our vision the fish is short-sighted. Instead of being lens-shaped the lens of the fish is globular or spherical, and normally the range of perfect vision must be only a little over 3 feet. Accommodation or the adjustment of the sight to objects of greater or less distance is not accomplished, as in land animals, by an alteration in the shape of the lens, but by the aid of a special muscle which moves the lens farther away from or nearer to the retina. Even in extreme cases this only gives a range of vision of slightly over 30 feet, which, however, is sufficient, having regard to the opacity of the medium in which the fish lives.

Since fish are able to discriminate between one kind of artificial fly and another, it follows that they can see objects in the air, which is as transparent for the fish as it is for us. On the other hand, there is no doubt that the fish can only see its prey or ground bait when in its immediate vicinity. In water of any depth, as in the sea, the amount of light present is materially diminished. In fish that live at any great depth the eye and pupil are usually enlarged, and the latter is subject to very little variation in size. In bottom-living and light-avoiding freshwater fish, such as the loaches, the eye is on the contrary relatively small.

The sense of touch is developed in the barbels of bottom-living fish, but in considering the reaction of the fish to its environment it is impossible to separate one sense from another, since working together they form a harmonious whole. There is more controversy about the auditory organ of fishes than about any of the others. On the one hand many observers believe that fish can hear well, while on the other hand there are those who deny the fish any sense of hearing.

The auditory organ in fish is much simpler in structure than in ourselves. In fishes the external ear and middle ear are entirely wanting, and the inner ear consists only of a

labyrinth with three semicircular canals. The vestibule of the labyrinth is dilated into one or more sacs containing the ear-stones or otoliths. There is no cochlea. In many bony fish there is a remarkable connection between the auditory organ and the air-bladder, as in the Perches, Herring and Carp. It is precisely those parts of the ear of higher vertebrates in which the actual hearing apparatus is situated that is missing in fishes, which therefore cannot hear in the sense that we do. The auditory organ in fishes is mainly a balancing organ. Fish are not only dumb, but deaf as well, at any rate in any ordinary meaning of the word. They are, of course, sensible to vibrations, but that is quite a different thing from the sense of hearing as met with in higher vertebrates. When the labyrinth or semicircular canals are damaged or injured, the fish loses its power of balancing the body. The otoliths grow from year to year by the accretion of layers of calcium carbonate, and afford like the scales a means of estimating the growth and age of the fish.

Fish are responsive to loud vibrations, such as explosions or footsteps on the river-bank, but that these sensations are at

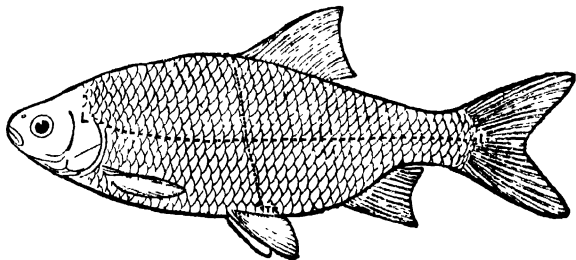


DIAGRAM TO ILLUSTRATE SCALE READINGS.

Ll. Lateral line. *TR.* Transverse line (p. 281).

all analogous to the sense of hearing in land animals is extremely doubtful. These vibrations may reach the fish's brain by means of the lateral line, which is considered by some authorities to

be the organ of a sixth sense in fish. Along the side of the body in many bony fishes is found a series of perforated scales to which the name "lateral" line is given. These scales cover a canal which runs along both sides of the body under the skin, extending forwards over the head in three branches, over and under the eye and along the pre-operculum round the lower jaw. This canal is filled with slime or mucus. Put rather baldly, the lateral line is a mechanical sense organ, enabling the fish to determine at once changes in the direction and strength of currents.

The fish of the British Isles, whether fresh water or salt, are a great natural as well as national asset. It is notorious that the stock of freshwater fish is nothing like it used to be, or ought to be. Indifference on the part of the public is largely responsible for this. The pollution of streams by sewage and manufacturing effluents, poaching and overfishing by netting, not only in estuaries but in fresh waters as well, all share in the blame for the present state of affairs. Fortunately public opinion is awakening, and the passing of remedial Acts of Parliament, notably in the case of pollution, is producing an ameliorative effect.

In the case of salt-water fish the conditions are widely different. Some fish—mostly those of pelagic habit—show no signs of overfishing, though they may and do show seasonal and annual fluctuations. Other sea fish, of which the Plaice may be taken as example, clearly show a marked and rapid decline in abundance. The cause of the decline in the case of sea fish is due to one cause and one cause only—overfishing. Since the present generation is the trustee for future generations in the matter of preserving our species of fish and of maintaining a reasonable supply of the same, it behoves us to consider briefly the measures that are, or might be, taken to prevent wholesale destruction, and to restock where overfishing has been allowed to go on in the past. The main remedies are

artificial hatching and rearing of fish, and legislative measures for protection, including size limits, the closure of fishing-grounds and the enforcement of a close season.

The hatching of sea fish may well claim a share of our attention, since it is based on the assumption that the fish population of our seas is falling off owing to overfishing, and that it is possible to remedy this decline by artificial means. In the British Isles marine hatcheries have been established by the Scottish Fishery Board at the Bay of Nigg, by the Manx Government at Port Erin, and by the Lancashire Sea Fisheries Committee at Piel. These institutions are not entirely devoted to the hatching of sea and shell-fish, but are also equipped for scientific research, and in the Scottish and Lancashire hatcheries fishermen's classes are established. The accounts relating to the building, equipment and upkeep of these institutions are not easily available, and it would in any case be difficult to estimate what proportion of the expenditure should be allocated to the hatching operations.

It has been repeatedly claimed on behalf of these institutions that results of direct economic importance have accrued from their operations, but in fact it would be difficult to justify their continued existence on that ground alone. As a matter of fact, these hatcheries are merely adjuncts to institutions devoted to marine research and to the education of fishermen.

These institutions are engaged in the hatching of various species of sea fish, including plaice, lemon soles, turbot, and cod; and it should be noted that, unlike similar freshwater establishments, no attempts at rearing the fish have up to the present been successful. It would appear, from various criticisms that have from time to time been published, that these hatcheries have been instituted without due inquiry into the occurrence of eggs and larvæ of fish in a state of nature. Few efforts have been made in this country to determine the "census" of the sea, if indeed such an operation is possible;

the first inquiries made on an extended scale into the quantitative determination of fish eggs and larvæ were made on the Continent. It need hardly be pointed out that the qualitative observations that have been carried out in this country as to the determination of floating organisms, inclusive of fish eggs, in the sea, afford no firm basis for generalisation into their relative abundance from year to year. In fact, the quantitative results obtained abroad are open to the serious criticism that they may not be fair samples of the floating population of the seas, but at any rate they serve to indicate the lines on which research should have been prosecuted before expenditure was incurred on schemes of rather doubtful utility.

It would appear that the bulk of the hatching operations are directed to the attempt to increase the supply of plaice; and during the twelve years ending 1913 the Scottish Fishery Board liberated 226 million fry of the plaice. The Annual Report of the Marine Biological Station at Port Erin for 1914 gives a total for the season's hatching of 7,707,350 plaice larvæ liberated; no other fish are now dealt with at these institutions. At the Lancashire Sea Fish Hatchery at Piel (now closed) about one million plaice and eleven million flounder fry were liberated in 1921. In 1924 the number of plaice fry liberated was 1,410,000; no flounders were hatched this year.

Another claim put forward in favour of the hatchery is that it serves as a reserve of spawners. The number of spawners in the various hatcheries is not always given. In the Scottish report for 1913 there is no statement as to the number of adult plaice in the spawning ponds; but in the ponds attached to the Hatchery at Port Erin there were 350 healthy plaice. The condition of these fish, which are confined under artificial conditions, is probably less favourable than it would be in a state of nature. In some of the hatchery reports we learn that "very few fish had died," and in others, "There is always a

certain amount of natural mortality among them, particularly during the summer." The mortality rate among spawners is nowhere expressed as a percentage. The claim that the hatchery provides a reserve of spawners or confers immunity on a number of spawners, will not bear detailed examination. Not only is there a mortality—the percentage of which is unpublished—once the fish are put into the ponds, but there must inevitably be a considerable mortality before the fish get to the spawning pond. Special hauls are made by the scientific steamers for the purpose of obtaining these fish, and the mortality that takes place during the trawling, the time the spawners are kept on the steamer and during transference to the spawning pond, should also be taken into account.

The theory that the spawning pond acts as a reserve of breeding stock may therefore be dismissed; the probability is that the percentage of mortality of these fish if left in the sea (from being captured by commercial trawling and from their natural enemies) is less than it is in the spawning pond, where the fish are detained under artificial, *i.e.* unnatural, conditions. In how many hatcheries are the spawners kept from year to year? Attempts have been made from time to time to obtain spawn from fish caught in commercial fishing. The writer has a vivid recollection of the difficulties of collecting spawn from steam trawlers in the Irish Sea in the spring of 1899.

A further point urged by the advocates of sea-fish hatching is that there is an enormous mortality of eggs and larvæ in the sea. While on *à priori* grounds the statement that there must be an immense destruction of eggs or larvæ or post-larval fish is indisputable, there is no clear evidence of the enormous destruction of pelagic eggs of marketable fish in nature. It may safely be said that no one knows what proportion of fish eggs or larvæ are destroyed in a state of nature.

In defence of fish-hatching "the risks of non-fertilisation" in a state of nature are touched upon. Here again there are

no definite statements as to the percentage, if any, of non-fertilised eggs. Such references are either non-existent or of the greatest rarity. This is in sharp contrast to the conditions obtaining in fresh water. According to Hutton, probably not more than one-quarter of the eggs of the Salmon are fertilised.

Although there is a great mortality in a state of nature somewhere in the life-history of the Plaice, we have no logical reason for believing that the period of maximum mortality is tided over in the hatchery.

It may be taken for granted that there is a considerable mortality in the sea. There is no evidence to show that this occurs before hatching; it possibly or even probably occurs after hatching, *i.e.* subsequent to the stage at which the larvæ are set free from the hatchery. No supporter of fish-hatching, however enthusiastic he may be, can conscientiously say that the thread-like larvæ at present liberated are at all capable of protecting themselves.

Another theoretical objection urged against the artificial propagation of sea fish for economic reasons is based upon consideration of the vast area of the sea as compared with lakes and rivers, and upon the enormous fecundity of most sea fish, especially those which, like the Plaice, produce pelagic eggs. But as Fulton, in an able and impartial paper on the subject, has pointed out, although the extent of the sea is vast, the parts frequented by edible fish—the fishing-grounds on which the fish are caught—are relatively small, usually confined to the neighbourhood of coasts, or to banks in close propinquity to them. Of recent years much information has been obtained with regard to the migrations of several valuable species, and we now know that, with regard to plaice at any rate, the extent of wandering is, especially in the early years, very small. In the case of marked plaice liberated by Fulton in the Firth of Forth and St. Andrew's Bay, by Meek on the Northumberland coast, and by the Lancashire Committee in the Irish Sea, nearly

90 per cent. of those recaptured were taken within a few miles of the place of liberation, sometimes after an interval of two years or more. The fact that the natural range of certain species may on the whole be quite restricted materially modifies the application of the argument based on the vastness of the sea.

In combating the argument against artificial hatching of sea fish based on the enormous fecundity of most edible marine species, Fulton to some extent supports our contention as to the fact that "there is not sufficient information to enable one to apportion with exactness the relative destruction that takes place in the egg stage and in the larval stage, or in the later stages.

"It would be of value in this connection if a large body of accurate information existed to show the relative proportions of the eggs, larvæ and post-larvæ of the food-fishes existing under natural conditions in the sea."

Sea-fish hatching is attended with difficulties not present in the case of freshwater or anadromous species. No one doubts that in areas of water under more or less complete control, piscicultural operations may be beneficial and profitable. Carp and oyster culture are instances. But where the areas are extensive, as in the open sea or the great lakes of North America; or where rivers are concerned, as in the culture of salmon; the conditions cannot be controlled, and indisputable evidence of success is most difficult to obtain. An increase following hatching operations may be due to natural causes or even to other kinds of artificial interference, such as fishery regulations. In spite of the absence of definite statistical evidence of the success of fish hatcheries, it is to be noted that certain fishery authorities are extending their operations in this direction from year to year. A notable instance is that of the United States of America. Although a large part of the fish culture of the United States is devoted to freshwater and anadromous forms, the Commissioner of Fisheries is evidently

not discouraged with the results of their marine work. In a recent report he says with reference to the marine species : " Unusual numbers of cod are reported all along the coast, and surprising catches have been made on inshore grounds. In spite of the growing scarcity of adult lobsters and the ruthless destruction of young and eggs during the last ten years, fishermen on the New England coast have been finding in their traps many more young lobsters than formerly ; flat-fish are much more numerous, especially small flat-fish, in the shallow waters along shore."

In Canada, Prof. Prince, the Commissioner and General Inspector of Fisheries for the Dominion, reports : " Public opinion is indeed favourable in the highest degree to the expansion of artificial fish-breeding in its various branches, and the federal government has not been slow to recognise the desirability of extending hatching operations."

It is only fair to mention that in the United States and Norway the fishermen in the neighbourhood where the fry have been liberated have frequently stated their opinion that the hatcheries are beneficial in increasing the supply of fish, and in years of abundance they attribute the increase to the operations of the hatchery. Fulton states that at certain parts of the coast of Aberdeenshire the line fishermen, who annually petition for supplies of plaice fry from the Scottish Fishery Board Hatchery at the Bay of Nigg, have also expressed the opinion that the liberation along the coast has increased the number of plaice in the inshore waters. The inshore trawlers of Morecambe Bay in Lancashire go even further. They say they can distinguish the plaice hatched and liberated from the Lancashire Sea Fisheries Hatchery at Piel, Barrow, from the local race. The fish hatched from Piel are of Scottish origin, their parents being obtained from the closed waters of Luce Bay. Although, personally, one is sceptical as to this, there can be no doubt of the existence of this opinion, which is

strongly held by a large section of these trawlers. It must not be forgotten that fishermen may support hatcheries as an alternative to restrictive legislation, apart altogether from the respective merits of these two methods of increasing the supply of sea fish.

Dr. Fulton points out that the results of fish-hatching operations may be tested in one of three ways. Either (1) by the introduction of a fish not indigenous to the region; or (2) by a system of special statistics of the fish caught in the region over a series of years when no fry were added to the waters, and over another series of years when fry were liberated; or finally (3) by special investigations to determine the abundance of the young fish in years when fry were added, and in years when they were not added.

Unfortunately, there is no available evidence under the first heading for marine fish, though there is very striking evidence in the case of an anadromous fish (the American Shad).

This fish was formerly non-existent in the Pacific, but in 1871 a consignment of 12,000 fry, about eight days old, from the Hudson River on the Atlantic coast, was put in the Sacramento River by the California fish commission. In 1873 another consignment of 35,000 fry was added; in 1876, 99,000; in 1877, 110,000; in 1878, 150,000; and in 1880, 215,000; the total being 621,000 shad fry. From these small colonies, amounting to less than 1 per cent. of the number now annually planted in the Atlantic slope rivers, the shad have multiplied and distributed themselves along nearly 3,000 miles of the coast from southern California to south-eastern Alaska. An adult shad is said to have been taken in 1873, and 16 were taken in 1874 and 1875; in 1876 and 1877 they had become quite common in the Sacramento River, and some were found along the coast over an extent of 400 miles. In the spring of 1879 several thousand mature shad were sold in the market at San Francisco; in 1886 the California Fish Commission esti-

mated that a million good-sized shad were taken in the waters of the State; and in 1895 it was reported that the shad was one of the most abundant fishes of California, the quantity taken being enormous. In recent years the fish has become so abundant that the price has gone down enormously, being often less than a cent per pound, and of the tons taken in the salmon-seines nearly all are now thrown back into the water or used as manure.

With the view of ascertaining the effect of the liberation of the fry of the Plaice, considerable numbers of them were transferred to Loch Fyne from the hatchery of the Scottish Fishery Board in the years 1896-1901, and a few months later the abundance of the young plaice found in certain localities in the loch was tested by fishing with a push-net on the beach. In the six years 1903-1908 no fry were placed in the loch, and the push-nettings were continued at the same places and at corresponding times in order to determine the abundance of young fish in the same way. The total number of the year's plaice which were obtained was 13,068, the collective results in the two periods being :

	No. of fry liberated.	No. of hours fishing.	No. of plaice.	Average No. per hour.
1896-1901 . .	142,880,000	74	6,491	87·7
1902-1908 . .	none	165½	6,577	39·7

It will be seen that in the first period when plaice fry were being put into the loch, the average number of young plaice taken was 87·7 per hour; whereas in the second period, when no plaice fry were added, the average number taken per hour was 39·7, or less than half. The average at each of the five stations where collections were made was less in the second period than the first, the decrease per hour ranging from 19·2 to 104·7. The collections were made in the months of June, July, August and September, and the mean number of young plaice taken per hour was less in each month in the second period than in the first, while, with one or two exceptions, this

was true of each of the stations considered separately. The fluctuations from year to year were very considerable, the mean annual average ranging in the first period from 24 to 174, and in the second period from 8 to 112. When the average was high at one station or in one month, it was also, with few exceptions, high at the other stations and in the other months, and similarly when it was low; therefore the numbers represent approximately an actual abundance or scarcity of the young plaice in Loch Fyne in the particular years.

The period of thirteen years over which these experiments have extended is a considerable one, and Dr. Fulton thinks it is reasonable to believe that the greatly increased average abundance of the young plaice in the first years was mainly due to the liberation of the fry from the hatchery; and that, on the other hand, the decrease in the abundance in the last six years was mainly owing to the fact that no plaice fry were added to the loch in those years.

The artificial propagation of freshwater fish such as salmon and trout is on a somewhat different footing from that of sea fish. In the latter case, the hatcheries—so far as Great Britain is concerned—are maintained by State assistance or grants from local authorities, and the young fish are hatched only, and not reared. They are set free in the sea in a very immature condition.

In the case of freshwater fish the hatcheries and rearing ponds in the British Isles are private ventures, and trout are reared at any rate to the age of three years and sold for stocking private waters. No attempt has hitherto been made in this country by the State to replenish freshwater areas with fish.

In the United States the salmon replenishment problem has been vigorously handled. In 1872 the Bureau of Fisheries distributed 30,000 eggs of the Chinook salmon. In 1910 this number was increased to over 30 million, and, in addition, over 2,750,000 fry were successfully planted. For the fiscal

year 1923 the collection of salmon eggs from the Pacific coast and Alaska amounted to 179 million, 50 million less than in 1922, the shortage being due to unusual water conditions. The earlier hatchery operations were largely restricted to California. In Alaska the first hatchery was erected at Kodiak Island in 1891. Up to 1900 the work of hatching salmon was entirely voluntary on the part of the packers, but in that year a law was passed making it compulsory on the packers to produce and liberate at least four times as many fry of the Sockeye as they had taken mature fish from the fisheries. In 1902 the number was raised to at least ten times. This regulation appears to have been more honoured in the breach than in the observance, and it was repealed by the law of 1906, according to which owners of private salmon hatcheries worked in Alaska shall be exempt from all licence fees and taxation at the rate of ten cases of canned salmon to every thousand Chinook or Sockeye salmon fry liberated. This was in effect subsidising salmon hatcheries. In 1923 two private salmon hatcheries were operated in Alaska as authorised by law.

While it is true that the conditions in the States and Alaska are very different from those obtaining in this country—in the size of the rivers, the stock of fish, the species of salmon dealt with and the huge commercial fishing—it certainly seems remarkable that greater efforts have not been made in Great Britain to try an experiment in a hatchery on a large scale in at least one or two selected rivers. But opinion in this country seems on the whole to be much less favourable to artificial hatching than in the States, and the chief idea as to the improvements in salmon fishing here seems to be based on the restriction of netting in the estuaries and the prevention of pollution.

In 1923 the Development Commissioners had before them a scheme for testing the effect of artificial hatching upon the stock of salmon in a river. For this purpose Sir Charles Ross of Balnagowan had offered the control of the River Oykel in

Sutherland, and was prepared to co-operate on a generous scale both financially and in other ways. The Commissioners did not see their way to afford any financial assistance to the scheme. It seems a great pity that an experiment of this kind cannot be tried in a thorough-going fashion, and it ought not to be impossible for the various salmon fishery interests of the British Isles to combine for this purpose.

The classification and nomenclature of British fish offer some difficulty, and there is still considerable diversity of opinion as to the correct scientific name to be applied, even to common fish like the Cod. The reason for using scientific names at all is that the common name of a fish has no precision; the same name may be given to different fish in different parts of the country, or, what is more commonly the case, the same fish may be called by different names in different parts of Great Britain. The term "whiting" has been applied not only to the common salt-water Gadoid, but also to various freshwater fish. Conversely, the common flounder is called White-fluke or simply Fluke, and the name Flounder is unknown to many inshore fishermen. In the case of some rare fish there is no common name, so the necessity for a precise name is obvious.

Fish are considered to be a class (Pisces) of the animal kingdom. This class is subdivided first of all into sub-classes, such as the Lampreys and Hags (Cyclostomata), Sharks and Rays and cartilaginous fish generally (Elasmobranchii), and so on. These sub-classes are again divided into orders, sub-orders and families. Usually the members of a family are closely allied forms. Families are again divided into genera and species. The Herring family (Clupeidæ) is divided into several genera, Clupea, Engraulis, and so on; the genus Clupea, for instance, comprising several species, such as the Herring (*Clupea harengus*), the Sprat (*Clupea sprattus*) and others. Unfortunately, there is no consensus of opinion amongst zoologists as to what constitutes a family or genus of

fish. Even in the case of the Herring family the exact limits of the genus *Clupea* are by no means agreed upon. Some ichthyologists would include the Shad as a species of *Clupea* with the name of *Clupea alosa*, others would place it under a distinct genus with the name of *Alosa alosa*. Now, although we are not concerned with the niceties of zoological nomenclature, we must be careful that the scientific names we use have a precise significance. Unfortunately, again, there is no consensus of opinion as to what is the correct scientific name for even such a common fish as the Cod, to take an example.

The precise system of nomenclature dates from the times of Linnæus, the great Swedish naturalist, who was the first to adopt the system of binomial nomenclature, that is, of giving two names to distinguish a species.

Confusion has arisen with regard to the scientific names of animals generally for various reasons. Two different naturalists may have successively described a given species of fish and given it different names. In this case the strict rule is that the first name has priority and should be adopted. But a further complication arises owing to the fact that in some cases a second or later name has been in use for generations and is generally applied to a given species. Subsequently it is discovered that another name has priority. The question then arises as to whether it is right or expedient to supplant a well-known and constantly used name for one which is less familiar or even practically unknown. Confusion has also arisen owing to naturalists describing different fish under the same name; or again, a description of what purports to be a given species, such as the *Raja circularis* of Day, may really include two distinct species. There are also other debatable points, which, however, lie outside the scope of this book.

The resulting confusion is (sometimes) avoided in scientific treatises devoted to ichthyology by giving a long list of synonyms for each species, and, generally speaking, in zoological books it

is customary when writing about a fish to give not only the full scientific name, such as *Clupea harengus* for the herring, but to add in an abbreviated form the name of the writer who first described and classified the species under that name, e.g. *Clupea harengus*, Linn. means that fish which was first described by Linnæus under the name of *Clupea harengus*, and, of course, is the fish popularly known as Herring. In this book the scientific names used for freshwater fish are those used by Tate Regan in his book on freshwater fish; for the marine species the scientific names used by Day are generally, though not invariably, used. To avoid confusion a full list of all the species mentioned, with the scientific names and authors, is given (p. 351).

Before passing on to describe the various species of fish in some detail it is well to consider what is a British fish. When Day published his work on British fishes forty years ago, the deep-sea fisheries of the British Isles were carried on by means of sailing boats, if not in the immediate vicinity of our coasts, then certainly at no great distance away. Fish landed by our fishermen in those days were quite reasonably considered to belong to the British Fauna. But at the present time our fishermen go to sea in comparatively large and powerful steam fishing-vessels. There is no comparison between an up-to-date steam trawler and the fishing-smack of Day's time. The fishing-smack of the 'eighties worked on the North Sea grounds, in the Channel and Irish Sea, within a day or two's sail from the home fishing ports. Even so the British sea fisheries were of some importance. The collection of statistics in the modern scientific manner was unknown at that time, but in 1885, the year after the publication of Day's book, an attempt was made by the Board of Trade to collect in a systematic manner the statistics of fish caught by British fishermen and landed on the British coasts. The total for 1885 for the whole of the British Isles amounted to 580,000 tons, of the value of

£6,076,000. In 1913 the amount was practically double, namely 1,232,837 tons, value £14,629,342. Nowadays a steam trawler may be a vessel from 150 to 175 feet in length, with a bunker capacity of 250 tons and a fish-hold capable of accommodating from 50 to 60 tons of fish. Vessels of this description now sweep the seas from Barents Sea, Iceland and the Faroes in the north, to Cape Spartel on the coast of Morocco in the south, and even more extended voyages are occasionally made. Our hardy fishermen trawl everywhere on the Continental Shelf on which the British Isles are situated, in depths from 5 to 100 fathoms and more ; in the immediate vicinity of the coast to localities a hundred miles or more from the nearest land. Consequently at our leading steam-trawler ports, such as Grimsby, Hull, Aberdeen, Fleetwood, Milford and Swansea, an immense variety and quantity of fish is landed daily throughout the year, much if not most of which is caught at considerable distances from our coasts. Some of the fish landed and sold in our markets can by no means be considered as belonging to the British Fauna. In the annual reports of the Ministry of Agriculture and Fisheries, thirty-four different kinds of sea fish are enumerated, including whitebait, which is not really a distinct species, but a mixture of the young stages of the herring and sprat. Apart from these classes a quantity of unclassified fish is landed. This unclassified group includes a great variety of fish ; the writer has seen exposed on hawkers' barrows in the streets of Preston such forms as *Argentina* (a deep-water Salmonoid from the western fishing grounds), *Serranus cabrilla*, *Hoplostethus* and *Trachyrhynchus*, all of which were undoubtedly caught on the remotest fishing-grounds. In 1923 and the early part of 1924 the following rare fish were landed by British steam trawlers at one port alone (Fleetwood) :—

The Blue Ling (*Molva byrkelange*).

“ Darkie Charlie ” (*Spinax niger*).

Bloch's Topknot (*Zeugopterus punctatus*).

Aphanopus carbo (Lowe). Caught off St. Kilda in 150 fathoms.

Trachyrhynchus scabrus (Rafinesque). Taken off the Bull Rock in 260 fathoms.

Notacanthus, probably *N. bonapartii* (Risso).

Coryphænoides rupprestris (Gunner).

Alepocephalus giardii (Koehler).

The exact locality from which these and other rare species are obtained is not always ascertainable. The question as to which ought to be included in the British Fauna and which rejected is not always easy to answer. For the purposes of this book the writer only includes, as British, fish which have either been washed up on our coasts or caught within a reasonable distance of the same. In particular, the 100-fathom line has been taken as the limit of depth for the inclusion of fish as British. The division is admittedly arbitrary, but limitations of space compel one to omit, or only refer to in the briefest possible manner, purely abyssal fish. The 100-fathom is a convenient boundary for several reasons. It marks the limit of the Continental Shelf; beyond it the Continental Slope drops down rapidly into great depths, and our commercially valuable fish are for the most part caught within the 100-fathom line, while beyond it a new and strange fauna rapidly makes its appearance. Doubtless some fish not referred to in this book, such as some of the Macruridæ, *Molva abyssorum* and others, stray within the 100-fathom line; but as these may quite reasonably be regarded as deep-sea fish pure and simple, they are omitted in the detailed account given below.

During the last thirty or forty years very great advances have been made in our knowledge of the habits and life-histories of fish, both freshwater and marine. The establishment of the Marine Biological Association with its laboratory at Plymouth and the researches carried on under the auspices of

the Scottish Fishery Board at the Scottish Universities have given us much valuable information. A great stride forward was made in 1899, when the Swedish Government invited the various maritime powers of Northern Europe to a Conference at Stockholm "to elaborate a plan for the joint exploration in the interests of the sea fisheries of the hydrographical and biological conditions of the Arctic Ocean and the North and Baltic Seas." As a result of this Conference the International Council for the exploration of the North and neighbouring seas was founded, with a central office at Copenhagen and a central laboratory at Oslo. The various North European countries interested in the Sea Fisheries participated in the work of investigation, each country being allocated a certain area of the sea for special investigation. Many of the countries participating in the work made, however, extended voyages for research purposes in vessels specially built and equipped for the work. A detailed reference to this is, however, impossible here. It must suffice to state that since 1899 a very large number of publications have been issued dealing with the sea fisheries and allied problems, and some of these publications are of a voluminous nature. The Central Bureau publishes from time to time volumes and pamphlets dealing with fish and fisheries and allied subjects, and in addition each country publishes separate reports of the investigations undertaken by its own specialists.

Those communications published in Great Britain are now issued under the authority either of the Scottish Fishery Board or the Ministry of Agriculture and Fisheries, both of which departments have now a staff of specialists exclusively engaged in these investigations. The publications of the Central Bureau are mainly in the English or German languages. It is no exaggeration to say that it would occupy the exclusive time and attention of an expert to read and digest the numerous reports which are now published with regularity.

DESCRIPTIONS OF SPECIES.

THE PERCHES (*Percidæ*).

The following table serves for distinguishing British fishes of the Perch family :—

1. Two distinct dorsal fins, separate or united only at the base.

2. Only one dorsal fin.

Group 1 may be divided thus :

Dorsal fin with nine spines ; anal fin with three spines.

The Bass (*Labrax lupus* or *Morone labrax*).

Dorsal fin with thirteen to fourteen spines ; anal fin with two spines.

The Perch (*Perca fluviatilis*).

Group 2 may be subdivided thus :

No canine teeth, all the teeth villiform.

Operculum with strong bony ridge ; opercles denticulated.

The Stone Basse (*Polyprion cernium*).

Operculum without bony ridge ; opercles spiniferous.

Ruffe or Pope (*Acerina vulgaris*).

Canine teeth present.

Preoperculum more or less serrated.

Body with seven or more dark brown cross bands.

Comber (*Serranus cabrilla*).

Body uniform brownish, no cross bands.

The Dusky Perch (*Serranus gigas*).

Preoperculum entire.

Distance between eyes and angle of mouth great.

Dentex (*Dentex vulgaris*).

The Freshwater Perch (*Perca fluviatilis*).

The Freshwater Perch is one of the best known and most handsome of our freshwater fish. A detailed description of its appearance is unnecessary (see Plate 1). The Perch has a wide distribution, ranging throughout Europe and Siberia. It is found in the Mediterranean and Black Sea rivers; in the Caspian and Lake Baikal. Although mainly a gregarious freshwater species, the Perch is also found in brackish waters, as in the Baltic, where it spawns in the bays and coastal waters in summer. There is a good deal of variation in the appearance of the Perch, a hump-backed variety being found in certain Welsh lakes. The Perch prefers water with a not too rapid current. In winter it retires to the deepest available water, where it remains in a sluggish condition. With the approach of spring the Perch leaves the depths. In April and May shoals of perch are seen near the river-banks, and here in shallow water spawning takes place, the fish being grouped in shoals according to size. The eggs are demersal, and are laid in long strings or ribbons (Plate 66) which sometimes are net-like in appearance, and are usually attached to water-weeds. The larvæ hatch out in eighteen days at a temperature of 50° F. When hatched the larva is five millimetres long, and for a time it floats at the surface. The Perch becomes mature in its third year. It attains a weight of 5 lbs. The record perch caught by fair angling in the British Isles weighed 5 lbs. 4 ozs., and was caught at Sandford Mill, Woodley, Berks, by Mr. Wm Leach in 1873. Two others of 5 lbs. each were caught in Daventry Reservoir in 1882 and 1908; and another of the same weight near Upway, Dorset, in 1870. In 1911

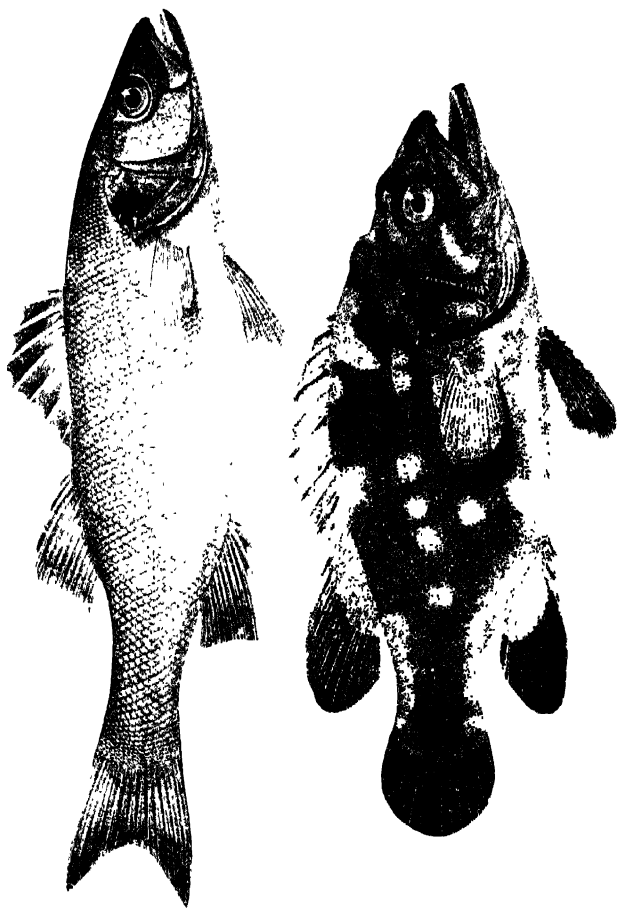
Mr. R. Graham caught a perch of 4 lbs. 13 ozs., and three others all over 4 lbs. each, in a pond in Derbyshire. A 6-lbs. 1-oz. perch is said to have been taken in Virginia Water by Osborne, the Royal fisherman, in June, 1875; and in 1899 Mr. L. Gordon took one of 5 lbs. 2 ozs. from the River Waveney; this was afterwards said to have been netted. The two heaviest perch on record—there appears to be no reason to doubt their authenticity—are a 10-pounder from Lake Bala and an 8-pounder taken from the Wiltshire Avon on a night line.

The Pope or Ruffe (*Acerina vulgaris* or *cernua*).

The Pope or Ruffe (Plate 1) is not very widely distributed in the British Isles, being confined to the south and midland part of England. It is absent from Scotland and Ireland. The name of Ruffe is said to be derived from the roughness of the scales. Essentially a freshwater species, the Ruffe is found in brackish waters in the Baltic, but never in really salt water. The Ruffe is found in fresh water in Siberia, Scandinavia and Northern Europe generally. Of gregarious habits, it prefers deep and shady water with a moderate current. Like its near relative the perch, it spawns in April and May in shallow water near the banks of ponds and streams. An adult female produces 205,000 eggs. The eggs are attached to weeds and submerged water-plants. The larvæ hatch out in twelve days at a temperature of 50° F. They are very small and helpless, measuring only three millimetres in length.

The Bass (*Morone labrax*).

The Bass (*Labrax lupus*, Day, or *Morone labrax*, Linn., or *Roccus labrax*, Linn.) is the commonest of our sea perches (Plate 2). Many writers now separate the Bass, Stone Basse





Red Mullet. (p. 37)
Greater Weever. (p. 70)

and the genus *Serranus* from the Percidæ and include them in the family Serranidæ. The Bass extends from the Mediterranean to the British Isles, becoming rare in the North Sea. In summer it is abundant in the brackish waters of our estuaries, particularly on the west and south coasts, where it is frequently taken by sea anglers. In the Bass all the teeth are villiform, and there are no canines. There are also teeth on the palatine bones, vomer and tongue. There are nine spines in the first dorsal and three in the anal fin. The scales (Plate 11) are rather small. The pre-operculum is serrated and provided with denticulations on its lower limb. The Bass spawns from May to August either in the sea, brackish or fresh water. In the sea its eggs float, *i.e.* are pelagic; in fresh water they sink to the bottom. The egg is of the usual pelagic type, measuring from 1·15 to 1·20 millimetres in diameter. The closely allied American species (*Morone lineata*), on the contrary, has large eggs of the type seen in the Shads, that is, demersal. In the Bass the larvæ hatch out in six days. The growth of the young is rapid, so that it leaves the inshore waters with the parent fish on the approach of winter. On the west coast of England and Wales the Bass usually appears in May and leaves again in October or November. This inshore migration is for spawning purposes.

Serranus and Polyprion.

There are three sea perches included in the genera *Serranus* and *Polyprion*, namely, the Comber (*Serranus cabrilla*), the Dusky Perch (*Serranus gigas*) and the Stone Basse (*Polyprion cernium*). These are comparatively rare in British waters, and since they are of no economic importance they may conveniently be considered together.

The Comber (*Serranus cabrilla*) (Plate 6) has distinct canines in both jaws. The body is orange-yellow with four or

five greyish longitudinal narrow bands, commencing just behind the eye. Two of these bands are confined to the head, the other three extend to the base of the tail. This fish is also called the "Gaper," because when it dies it erects the fins and opens the mouth, thus producing an effect of stiffness. The Comber is a fish of the Red Sea, Mediterranean and eastern Atlantic, wandering northward to our southern coasts, where it attains the length of a foot. The spawning period is in the summer months. The egg is pelagic, 0.90 millimetre in diameter, with an oil-globule.

The Dusky Perch (*Serranus gigas*) is a Mediterranean and south Atlantic species, very rarely straying into British waters. Day gives three British records, all from the south coast. It is distinguished from the preceding species by the absence of the longitudinal bands on the sides of the head and body. Nothing is known of its habits and development.

The Stone Basse (*Polyprion cernium*, or *Polyprion americanum*) is a deep-water sea perch of the tropical Atlantic and Mediterranean, which occasionally wanders as far as our south coasts. A large species, the Stone Basse attains a length of 6 feet and a weight of 80 lbs. and more. The dorsal fin has eleven spines, the anal three. The fins are very dark (Plate 2). The Stone Basse has the habit of accompanying floating timber. Nothing is known of its spawning habits.

Dentex (*Dentex vulgaris*).

This is a rare species in British waters, there being four records for Great Britain and one for Ireland up to the end of 1903. The British records are from Troup Head, Banffshire (Edward), off Hastings (Donovan, 1805), Falmouth Market twice (Couch, 1846 and 1851), and Dingle Bay, caught by a sailing trawler in April, 1903 (Holt).

Since then Cunningham mentions a specimen of 35 inches

said to have been taken near Weymouth, and the author caught four small specimens in a trawl on the Lancashire fishery steamer in four-fathom water off the Gimlet Rock, Pwllheli, in September, 1905. The identification of these specimens was confirmed by Holt.

Dentex has a moderately stout, sub-fusiform body. The head is large and stout, nearly one-third the length of the body, with a large occipital hump reaching further forward than the level of the front of the eye. There are two large canine-like teeth on each side of either jaw, followed by a series of smaller sharp-pointed teeth. The dorsal, pectoral and pelvic fins originate in the same vertical line, the pectoral fin being somewhat falciform and the caudal deeply emarginate. The dorsal and anal fins have a scaly basal sheath into which they can be depressed. The colour is not unlike that of the common bream, with a faint ancillary spot and small black markings, more numerous in the young, on the upper part of the head and back. This species grows to a length of 3 feet 4 inches or thereabouts. The Dingle Bay specimen recorded by Holt weighed 28 lbs., and was remarkable for the great development of the hump above the eyes, which is probably an adult character and may be a sexual characteristic of the male, that being the sex of the Dingle species, which was sexually mature. An occipital hump is characteristic of the adults of several families of fish, such as the Wrasses (Labridæ) and Sea Breams (Sparidæ). This hump is composed of fatty tissues.

In *Dentex vulgaris* the eggs are probably pelagic, but little or nothing is known of its spawning habits.

MULLIDÆ.

The Red Mullet (*Mullus surmuletus*).

In the Red Mullet (Plate 3) the body is low and slightly compressed, covered with large thin scales. Two short dorsal

fins are present, the first of which is spiny, the second soft. The pectoral fins are underneath the first dorsal, the pelvics immediately underneath the pectorals. There are two long barbels under the chin; they are erectile, and can also be laid back in a groove between the sides of the lower jaw. The lateral line is continuous. The mouth is anterior, with a rather short and lateral cleft. The teeth are in two rows in the lower jaw; they are blunt and feeble. There are no teeth on the upper jaw or on the tongue; there are teeth on the palate.

The eyes are lateral and of moderate size.

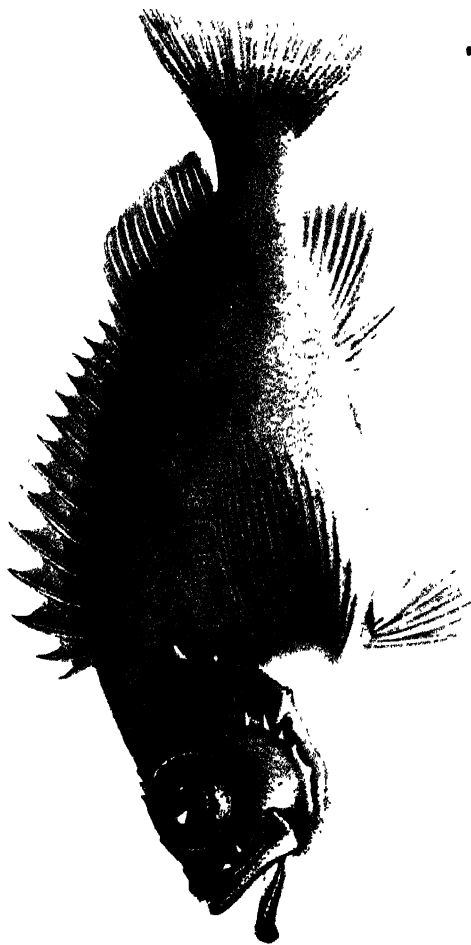
There are quite a number of red mullets, only one of which reaches our shores. This is the Red Mullet, of which two distinct varieties are generally recognised, one plain red, the other also red on the back and sides, with from three to five bright yellow bands passing along the sides of the body from head to tail.

The Red Mullet is a southern species, but ranges as far north as Norway. It is abundant in the Mediterranean. In British waters it is rarely taken in any numbers except on our south and south-west coasts where it is a regular summer migrant. In the Irish Sea the writer has only seen this species caught at Bardsea Island, off the Carnarvonshire coast.

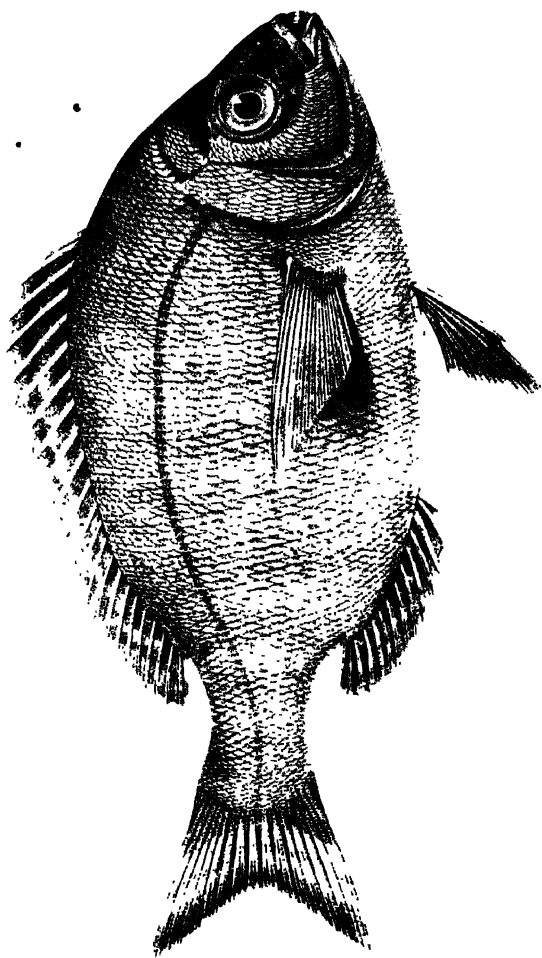
The Red Mullet was one of the favourite fish of the Romans, by whom it was highly esteemed as an article of diet. Apparently, in order to enjoy the feast it was necessary to watch the changes of colour in the dying fish, so that it was brought alive into the banqueting-room, in order that the guests might "enjoy" the colour changes. Fabulous prices are said to have been paid for this fish in ancient times.

Their food consists of shrimps, molluscs and worms.

The Red Mullet spawns in June and July. The egg is pelagic, and has a diameter of from 0·81 to 0·91 millimetre. The young larva hatches out in from three to four days, and is easily recognised since the yolk sac projects forward well in



Norway Haddock. (p. 43)



advance of the head, the oil-globule being placed at the extreme end of the projecting portion.

THE SEA BREAMS (*Sparidæ*).

The Sea Breams are recognised by their compressed oblong body, which is covered with scales. The dentition is very characteristic, there being more or less broad, cutting and conical teeth in front of the jaws and molars behind. The palate is toothless. There is a single dorsal fin consisting of a spiny and soft portion of nearly equal development. The anal fin has three spines. The lower rays of the pectoral fin are usually branched; the ventrals are thoracic in position, with three spines and five rays. The Sea Breams are subtropical in habit, and where they occur in any abundance are esteemed as food. In the British Isles they are not considered as prime fish.

The following characteristics serve to distinguish those members of the *Sparidæ* which are found in British waters :—

1. More or less broad and trenchant teeth in front of the jaws. No molars.

2. Conical teeth in front and molars at the sides.

Division 1 may be subdivided thus :

Teeth cardiform or villiform in front; those of the outer row slightly compressed and lanceolate.

Old Wife (*Cantharus lineatus*).

Teeth in front are broad incisors notched at the cutting margin.

Bogue (*Box vulgaris*).

The second division are separated by :

Canine teeth. Upper molar teeth in two or more series.

Scales large, 53 to 58 in lateral line.

Couch's Sea Bream (*Pagrus vulgaris*).

Scales small, 75 to 86 in lateral line. A crescentic golden band between the eyes.

The Gilt Head (*Pagrus auratus*).

Canine teeth absent.

A large black shoulder spot at commencement of lateral line.

Common Sea Bream (*Sparus centroidontus*),
Numerous small blue spots on body; black spot in axil of pectoral fin.

Spanish Bream (*Sparus bogaroveo*).
Head large, $3\frac{1}{2}$ to $3\frac{2}{3}$ in total length. Five rows of scales across the cheeks. Axillary Bream (*Sparus owenii*).
Five rows of scales across the cheeks. (*Pagellus acarne*).
Six rows of scales across the cheeks.

Pandora (*Sparus erythrinus*).

The Sea Breams.

In the official returns of the Ministry of Agriculture and Fisheries the Sea Breams are grouped together. The Sea Breams landed by our fishermen include several species of Sparidæ, but by far the most important is the Common Sea Bream (*Pagellus* or *Sparus centroidontus*), large quantities of which are caught to the south and west of Ireland.

Since, apart from the Common Sea Bream (Plate 9), the various species are of no great economic importance, it is convenient to consider them together, the above table giving sufficient information to enable one to determine the different species apart. The Sea Breams are most easily recognised by their dentition, which is more specialised than in most fish. They are inhabitants of tropical and sub-tropical waters, and are caught by our trawlers in deep water off the south and south-west of Ireland.

Of the British species the Black Sea Bream (Plate 5), or Old Wife (*Cantharus lineatus*), is met with frequently in the Mediterranean and eastern Atlantic, appearing every summer off our western coasts and in the Channel, where it attains a length of 20 inches. Records of this fish in the Channel are fairly numerous, but north of the Channel it is a very rare visitor. It has been recorded by Holt, who obtained one 6½ inches long at the junction of the Tamar and Lynher rivers (1897); and, though not mentioned by Parnell in his essay on the Fishes of the Firth of Forth and its tributaries, there is a stuffed specimen in his collection in the British Museum. It has also been described and figured from the Firth of Forth. One was taken 8 miles east of the Tyne in November, 1926.

Nothing is known of its habits and life-history, but there is reason to think the Black Sea Bream has demersal eggs, while the other members of the family produce pelagic eggs.

The Bogue (*Box vulgaris*) is also a Mediterranean species which occasionally migrates into British waters, where Day gives three definite records of its appearance. The Bogue has a more elongated and slender body than the other breams.

Couch's Sea Bream (*Pagrus vulgaris*) is recorded by Day from a single "undoubted British example," but there seems some confusion about his description, the figure given being from Couch's stuffed example and the teeth figured from another specimen described by Steindachner.

The Gilt Head (*Pagrus* or *Sparus auratus*) is a common species of the eastern Atlantic and Mediterranean, and undoubtedly wanders into British waters, being taken not only off our southern coasts but in the North Sea as well. This is a handsome fish, the top of the head being iridescent green with a crescentic golden band between the eyes.

Of the five species of *Pagellus* or *Sparus*, the Common Sea Bream (*Sparus* or *Pagellus centrodontus*) is the only one taken in large quantities by our fishermen. It lives in the deep

water of the Atlantic and appears to enter the Channel and the North Sea every summer, sometimes wandering as far as Norway. Like all the other Sea Breams it is rarer as we go north.

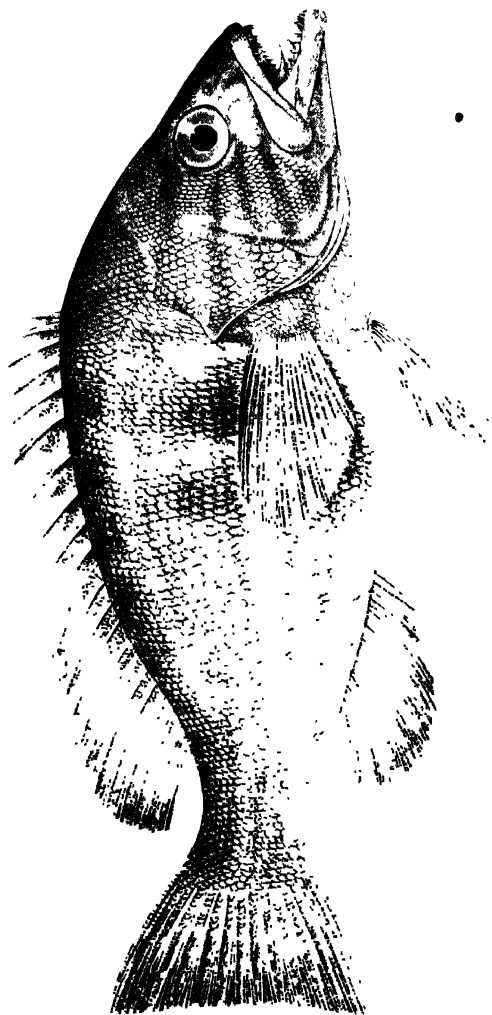
The Spanish Bream (*Sparus* or *Pagellus bogaroveo*), a Mediterranean species, also strays into British waters. According to Day it is not uncommon off the Cornish coast, being well known to the fishermen there. A specimen was caught in the trawl six miles off Tod Head, Aberdeen, in December, 1901, and brought into Aberdeen market; and another was caught twelve to fourteen miles off Aberdeen in January, 1903 (Sim).

The Axillary Bream (*Sparus* or *Pagellus owenii*) is only known from a few specimens taken off the coasts of the British Isles.

Pagellus acarne, an eastern Atlantic species, is reported to pay occasional visits to British waters. There is a definite record in Day, from Headslow in Cornwall.

The Pandora, King of the Breams, or Spanish Sea Bream (*Sparus* or *Pagellus erythrinus*), a common Mediterranean species, appears with more or less regularity on our south and west coasts, entering the North Sea at times and occasionally wandering into Norwegian waters. According to Gunther this species is not rare on the south coast of England, where it is known as "Becker." There is a specimen from Dingle Bay in the Irish National Museum.

Evidences of the occurrence of these rarer Breams on our coasts is not always satisfactory, and further information is greatly to be desired.



Comber, *Pagrus*



1



2



3



4



5



6

Millers Thumb or Bullhead. 1 Bright coloured. 2 Dark coloured. (p. 46)
Sticklebacks. Three-spined

Sticklebacks. Three-spined. 1 Bright coloured. 2 Dark coloured. (p. 46)

SCORPÆNIDÆ.**The Norway Haddock** (*Sebastes norvegicus*).

At one time it was thought that the Norway Haddock (Plate 4) was the sole British representative of the family *Scorpænidæ*, but of recent years there are records of an allied fish, namely *Scorpæna dactyloptera*, from British waters. A brief reference to *Scorpæna* is therefore given below.

The Norway Haddock is easily distinguished by its colour alone. The whole surface of the body is coloured red, which is only slightly less intense on the under side. The *Scorpænidæ* generally are marine bottom-living fishes of carnivorous tendencies; many members of the family have appendages resembling the fronds of seaweeds, which enable them either to hide or to attract other fish.

The Norway Haddock is a perch-like fish with the head and body compressed. The top of the head is scaly right up to and even beyond the orbits. The head generally has a spiny appearance. The eyes are large, the dorsal fin long, but the fin rays are not elongate; there is a notch separating the spinous from the soft dorsal. There are twelve to thirteen spines in the dorsal and three in the anal fin.

The teeth are small and villiform in the jaws, on the vomer and generally on the palatine as well.

The Danish name for this species, "Rodfisk," is derived from its remarkable colour.

A northern deep-water fish, the Norway Haddock, as its popular name indicates, is abundant off the Norwegian coast, ranging from Trondjhem southwards. It is also found off Sweden and Iceland. The young and larval stages have been taken off Spitsbergen, Bear Island and in the Faroe Channel. This species is much more common in the Continental markets than in our own, though it is occasionally seen in our markets

and not infrequently taken off our northern coasts. It is also found on the American side of the Atlantic.

The flesh of the Norway Haddock is highly esteemed in Norway and on the Continent generally.

Formerly two distinct species of Norway Haddock were recognised. A smaller coastal form very abundant in Norwegian fiords, and farther north right up in the Arctic, was described as a separate species under the name of *Sebastes viviparus*, but it seems that the differences between this smaller form and the larger are not sufficient to justify our regarding it as a distinct species, and it is really only a local variety of the Norway Haddock.

The Norway Haddock reaches a considerable weight; specimens of over 20 lbs. weight have been recorded, but fish of this size are extremely rare: a fair average weight is about 4 lbs.

The Norway Haddock lives on crustacea, molluscs and small fish. It is a gregarious species, frequenting rocky grounds for choice.

A remarkable feature of the Norway Haddock is that it is viviparous. The eggs are small, and an adult female produces from 18,000 to 148,000 according to size.

It is not likely that all these eggs mature at the same time. The fish gives birth to the young in April and May, or even as late as July and August. The young at birth are only 6 millimetres long; for a time they live in the upper layers of water.

Scorpæna (*Scorpæna dactyloptera*).

Of the members of the genus *Scorpæna* only one is present in British waters. *Scorpæna dactyloptera*, a northern fish of bottom-living habits, quite common off the Norwegian coast, is certainly found off our shores. Holt records young forms of 4 to 5 centimetres in length in 80-fathom water off the southwest of Ireland, but nothing is known of the spawning or

development of this species. At various times the young have been obtained in large numbers over great depths in the North Atlantic, and possibly the Scorpæna, like the Norway Haddock, is viviparous. In Scorpæna there is a transverse naked depression on the occiput, which is not present in Sebastes. The bones of the head have skinny tentacles in Scorpæna, but not in Sebastes. According to Sim there are numerous records of this species off Fraserburgh and the east coast of Scotland generally. It is reported to be abundant off Troup Head in depths of 40 to 110 fathoms, where it attains a length of from 18 to 20 inches. In 1894 the species was trawled in March and April south-east of May Island (T. Scott).

This species was added to the Irish Fauna by Spotswood Green, who caught several specimens from the south-west coast of Ireland in 250 fathoms in 1889.

THE BULLHEADS (*Cottidæ*).

Many ichthyologists include the Bullheads and Gurnards in one family, the *Cottidæ*, but it is more convenient to divide them into two, restricting the Bullheads to the *Cottidæ*, and creating another family—*Triglidæ* for the gurnards. There are close structural resemblances between these two families, but the mode of life and habits of the Bullheads and Gurnards are very dissimilar. The family of the *Cottidæ*, in the restricted sense in which the term is here used, includes fishes of small size, not active swimmers, and of coastal habit. They are characterised by a broad depressed head which is rounded in front. The body is sub-cylindrical, scaleless, provided with a lateral line and compressed posteriorly. The pectoral is rounded, with some or all of the rays simple. The jaws and vomer have villiform teeth. There are no teeth on the palate. There are four British species of the genus *Cottus*, which are thus distinguished:

First dorsal fin narrow, only half as high as the second.
No spine on the opercular bone or above the eye. Lives
in fresh water. Not above 5 inches long.

Miller's Thumb (*C. gobio*).

First dorsal fin nearly as high as the second. A spine above
the eye and four principal spines on the gill cover.

Short-spined Sea Scorpion (*C. scorpius*).

Five principal spines on the gill cover, the uppermost of
which is long and rough.

Long-spined Sea Scorpion (*C. bubalis*).

Two pairs of large rough tubercles on the upper surface of
the head. A row of similar tubercles or two rows along
the sides. The Four-horned Scorpion (*C. quadricornis*).

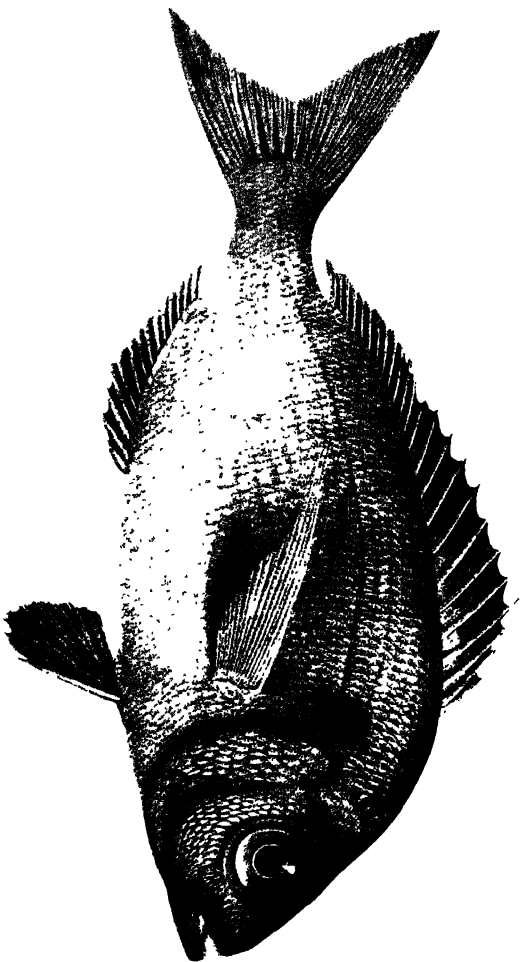
The Miller's Thumb (*Cottus gobio*).

This, a freshwater species, has a distribution which practically coincides with the European drainage area, being found all over Europe except in Spain and Greece. In the British Isles it is found in England and Wales, but not in Scotland or Ireland.

The Miller's Thumb (Plate 7) is a small species, the average length being from 3 to 4 inches; the maximum recorded is 6 inches. It is devoid of scales. The head is broad, depressed and rounded in front, the body sub-cylindrical, tapering posteriorly; the upper surface of the head is covered with a movable skin. A strong backwardly directed spine is found at the angle of the pre-opercle. There are two dorsal fins, the anterior being spinous, short and low. The posterior fin is immediately behind, is soft, longer and higher than the anterior. The pectorals are large and rounded, with a broad oblique base; the pelvics, consisting of a small spine and three or four simple rays, are inserted in front of them. The colour is very variable; the upper surface of the body is greenish-yellow to



Long Spined Sea Scorpion. (p. 48)
1 Male 2 Female



D. 9

Common Sea Bream. 1140.

D. 47.

brownish, the lower surface lighter, usually yellowish-white. The dorsal, caudal and pectoral fins are barred with series of dark spots.

The Miller's Thumb is a solitary fish, and is found lurking on the gravel or beneath stones at the bottom of clear streams. It feeds on insects or their larvæ, on crustacea and other small fry. A somewhat sluggish fish, it clings to the bottom, never swimming in mid-water; when disturbed it can dart from its hiding-place with considerable rapidity, but is incapable of swimming any great distance. It is a greedy fish, and will attack other species, such as the minnow or gudgeon, as large as, or larger than, itself.

The Bullhead, or Miller's Thumb, spawns in March or April. The fish pair off together, the female depositing her eggs in shallow-running water. Usually a nest of sorts is prepared by scooping out a hole under a stone. The pinkish egg-mass consists of about a thousand eggs, each of which is rather large. The male parent guards the nest during the incubation period, which lasts about a month.

The Bullhead is able to protect itself against the attacks of other fish and even of birds by means of the spines with which it is provided. According to Day, owls have been observed to eat Bullhead, and in 1880 a Grebe was found dead, having been choked in the attempt to swallow a Bullhead. The Bullhead is also remarkable from the ease with which it changes its body colour under the influence of the emotions of greed, anger or fear. According to Pennant, "The colour of this fish is as disagreeable as its form, being dusky, mixed with a dirty yellow; the belly whitish."

The Father-lasher, or Short-spined Cottus (*C. scorpius*).

This species has a very wide distribution. It has been recorded in Greenland, where it is said to attain a length of

6 feet. On the west side of the Atlantic it extends south to Maine, and on the east side to the Bay of Biscay. It extends throughout the Baltic to Finland. Day says of this species that "In Greenland it has been observed to deposit its eggs on the seaweed in December and January." Its eggs are very small, and in this country are extruded during the spring in the sand or in pools in the rocks.

In the British Isles the Short-spined Sea Scorpion (Plate 10) spawns from December to March, laying a clump of eggs about the size of a man's fist between tide marks in clefts in the rocks. The egg mass is of a somewhat spongy structure, and varies in colour from roseate to orange or straw-yellow (Plate 48). The eggs are from 1·5 to 2 millimetres in diameter, and are protected by a thick and tough capsule. Development is slow, and masses of eggs with advanced embryos are often found in April or even in May. The vitality of the larvæ is remarkable. McIntosh says they will survive for a fortnight in March, in a small quantity of water, in a glass vessel 2 inches across and 1 inch deep. Swarms of the early post-larval stages are captured in tow-nets in the Firth of Forth in March and April. Young forms of from 2½ to 3 inches long taken in February are about a year old, and some only a little larger, not quite 4 inches long, were sexually mature.

The Father-lasher is common in rock pools and shallow water all over the west coast. It is commonly taken in shrimp trawls in the Lancashire estuaries, and has a curious habit of emitting a grunting sound when taken from the water. It feeds largely on shrimps and small crustacea.

The Long-spined Sea Scorpion (*Cottus bubalis*).

This species, like the other Cottoids, is a shore-haunting form. Generally speaking, the Bullheads are coloured brownish or yellow, but there is considerable variation in the colour and

markings. Occasionally on the south coast brilliant red or carmine-coloured specimens of this long-spined species are taken, and Cunningham thinks that these always come from rather deeper water and live amongst red seaweed.

The long-spined species (Plate 8) is smaller than the short-spined, usually only 6 to 9 inches in length and rarely or never exceeding 12 inches. According to Meek it is confined to the north-east Atlantic extending from Norway to the Bay of Biscay and into the Baltic. Cunningham says it is found in the Arctic regions and in America, and extends farther south than the short-spined form. The eggs are deposited from February to April in orange-coloured masses, about the size of a walnut, between tide marks (Plate 37). The clump of eggs is assiduously guarded by the male parent. The diameter of the eggs is from 1·70 to 1·88 millimetres. The capsule is corrugated, and there are numerous oil-globules in the egg. Incubation lasts about six weeks, and the larvæ when hatched are larger, better developed and more active than larvæ hatched from pelagic fish eggs. As a general rule demersal eggs are larger and contain more yolk than pelagic eggs, and consequently the period of incubation is longer and the young larvæ better fitted for the struggle for existence. The larva of *Cottus bubalis* is pelagic, and has been obtained some miles from the shore.

The Four-horned Cottus (*C. quadricornis*).

This species (Plate 50) belongs more particularly to the Arctic regions and the upper part of the Baltic, but is found, nevertheless, occasionally on British coasts. It is circumpolar in distribution, but in restricted regions. The spawning season is November, December and January in the Baltic. The roe, like that of the Perch, is deposited in one single mass. In Sweden it spawns in freshwater lakes. The eggs are said to be watched

and protected by the male parent. They have not been identified with certainty in the British Isles.

THE GURNARD FAMILY (*Triglidae*).

The Gurnards are distinguished by the head being strongly protected with bony plates and spines. There are usually spines along the lateral line and at the base of the dorsal fins. The pectoral fins have three free rays which act as feelers.

The British members of the family are thus distinguished :

Serrated spines along the lateral line. Raised ridges running from back along side of body forwards and downwards. Streaked Gurnard (*Trigla lineata*).

Elongated spineless scales along lateral line. Deep red colour. Red gurnard (*Trigla pini*).

Pectorals enlarged, coloured deep blue behind. Colour brownish-red. Tub or Yellow Gurnard (*Trigla hirundo*).

Colour, slate-grey with white spots. Spinous points on lateral line. Grey Gurnard (*Trigla gurnardus*).

Pre-orbital bone elongated and toothed anteriorly. Pectoral large but not coloured as in the Tub.

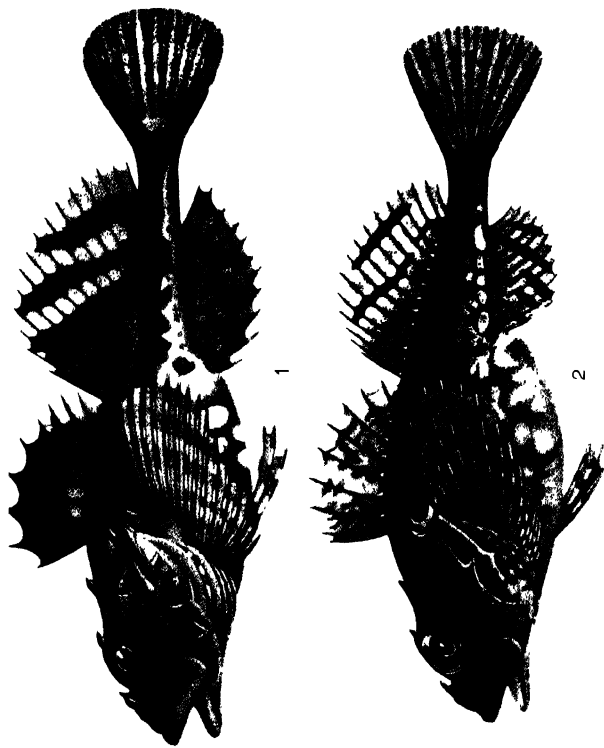
The Piper (*Trigla lyra*).

Second spine of dorsal fin much elongated. Shining silvery band along side of body.

Shining Gurnard (*Trigla obscura*).

The Tub-fish (*Trigla lucerna* or *hirundo*).

The Tub or Yellow Gurnard (Plate 13), as it is called by Lancashire fishermen (the *Trigla hirundo* of Day), is distinguished by its enlarged pectoral fins, which reach behind the commencement of the anal. These pectoral fins are coloured a deep rich blue on the hinder surface. There are no spines along the base of the dorsals. Of the three species common in



Short Spined Sea Scorpion. 1 Male 2 Female (p. 47)



1



Fig. 11.

1. Scale of Herring, showing one winter ring
2. Otolith of Dab, showing three summer areas
3. Scale of Bass, showing four winter lines, five summer areas

Fig. 51.

the Irish Sea and off the west coast generally this is the largest, sometimes attaining a length of nearly 2 feet.

The Yellow Gurnard, Latchet or Tub, as it is sometimes called, ranges from Norway to the south-west coast of England. Like the Red Gurnard it is rare in the North Sea.

In this species the air-bladder is divided into a large central chamber and two small chambers, one on each side, communicating with the central chamber at the front end. At the posterior end of the central chamber a divisional wall runs across obliquely; in the middle of this wall or curtain there is a hole. The air being pressed to and fro through this opening causes a sound. The eggs of this species are hard to distinguish from the others. The spawning period is one of the latest of marine fishes, lasting until the middle of October.

The Red Gurnard (*Trigla pini* or *cuculus*).

The Red Gurnard (the *Trigla cuculus* of Day) is the smallest of our common Gurnards (Plate 12). In colour it is deep red, much deeper than the reddish tint of the "Yellow" Gurnard, which may be mistaken for it by inexperienced observers. The chief distinguishing characters of the Red Gurnard are the scales on the lateral line, which, though devoid of spines, have the form of narrow plates across the line.

The Red Gurnard, though not uncommon on the south and west coasts of the British Isles, is rather rare in the North Sea and off the Norwegian coast. In the Irish Sea it is the second in order of abundance, coming next to the Grey but in front of the Yellow Gurnard. The Red Gurnard apparently inhabits rather greater depths than the other common species, but more information on this point is required. It spawns from April to June. The eggs are very similar to those of the Grey Gurnard, both in size and appearance. According to Cunningham the embryos hatched out at Plymouth in six days.

The Grey Gurnard (*Trigla gurnardus*).

The Grey Gurnard (Plate 17) is by far the commonest of the British Gurnards. It is quite exceptional to make a haul with the trawl anywhere in the Irish Sea without capturing a few specimens of this species. The Grey Gurnard is distinguished, not only by its grey colour and white spots, but by the absence of spines along the bases of the dorsal fins and the presence of spinous points along the lateral line. In size it is one of the smallest of our gurnards, the only common smaller one being the Red Gurnard. The Grey Gurnard rarely grows to a length of 18 inches.

Gurnards are found widely distributed in medium and shallow waters in temperate and tropical seas. They are bottom feeders, the three separate rays of the pectoral fins serving as feelers, performing the same function as the barbels in the various members of the cod family. The gurnards have another peculiarity, and that is they utter faint grunts when removed from the water; these sounds are produced in the air-bladder.

Of the six species which are recorded from British waters only three—the Grey, Yellow and Red Gurnards—are at all abundant. The other species are more southern forms, and only occasional wanderers reach our shores.

Gurnards form an important, if subordinate, part of our trawlers' catches. and as a food they are by no means to be despised. It is notoriously difficult to be dogmatic about the excellence of flavour of different fish, but in the writer's opinion the tail end of the gurnard, when properly cooked, should occupy a much higher place in the public esteem than it does at present.

The Grey Gurnard is the most northern in its distribution, ranging from the Mediterranean to Norway and the Baltic.

It feeds principally on crustacea, fish such as sand eels being the next important article of its diet.

The Grey Gurnard spawns from April to August. The eggs are pelagic, from 1·6 to 1·55 millimetres in diameter, with a reddish or yellowish oil-globule. The eggs of the various species of gurnards are not easily distinguished from one another. At a temperature of 15° C. the embryo of the Grey Gurnard hatches out in five days. The yolk is absorbed in from one to three weeks after hatching. The Grey Gurnard attains a length of from 4 to 6 inches in its first year, becoming mature in the case of the male at a length of 7 inches, and in the female at 9½ inches.

The Streaked Gurnard (*Trigla lineata*).

This species (Plate 17) is distinguished by raised ridges passing from the back in a forward oblique direction down the sides. The lateral line is provided with saw-like spines, and there are spines along the bases of the dorsals.

This, like the other gurnards which are rare in British waters, is a southern species ranging from our south-west coasts to the Mediterranean and the Canary Islands. Up to Day's time there were two records of this fish from Scottish waters ; it has subsequently been recorded as caught in the trawl 8 or 9 miles off Stonehaven in January, 1896 (Sim).

The Long-finned Gurnard (*Trigla obscura*).

The Long-finned Gurnard is distinguished by the much-elongated second spines of the dorsal fin. There is a shining silvery band along each side of the body, so that this species is sometimes known as the Shining Gurnard. This is a southern and Mediterranean species rarely straying into British waters, but a number were taken off Start Point in March, 1897, by Holt, according to whom this fish, which is distinguished by

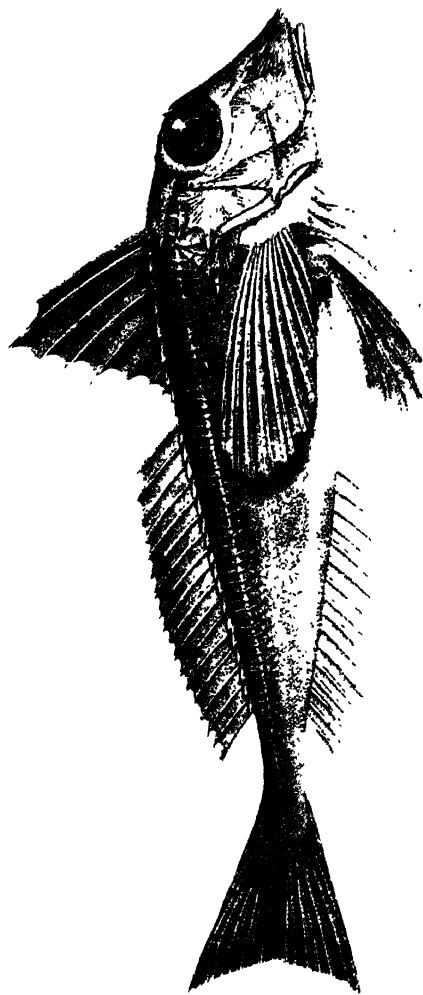
the attenuated form of the body, is known locally at Plymouth as the "Offing Gurnard," and is not uncommon, being frequently trawled on rough ground off Start Point.

The Piper (*Trigla lyra*).

In this species (Plate 15) the bones of the front part of the head above the upper jaw project forward in two large flat plates, toothed along their front edges. The pectoral is large, but not so brilliantly coloured as in the Yellow Gurnard. The spines in the opercular region are especially long and strong. A southern species, the Piper is only met with off our south and south-western coasts. Very little is known of its habits and development. There is only one record for the Irish Sea, a specimen taken at Aberffraw (Anglesea) in 1903 is now in the Bangor University College Museum. There is a specimen from the south of Ireland in the Irish National Museum.

A species closely allied to the gurnards, *Triglops murrayi*, has been recorded at rare intervals in the North Sea and off the Scottish coast. The characteristic features of the genus *Triglops* are that the body has a series of bony plates along the dorsal fins, and oblique and separate series of small ciliated scales beneath the lateral line. There are no palatine teeth. Sim records a specimen captured 14 miles off Aberdeen in October, 1890, four off Montrose in February, 1891, and one off Kincardineshire in September, 1891—all taken in the trawl. It has also been caught off the Mull of Cantyre and Sanda Island in 1887–1888, and figures in the *Proceedings* of the Royal Society of Edinburgh by Gunther in 1889. Another record is a specimen taken from 25 to 28 fathoms, west of May Island in November, 1890 (T. Scott).

In October, 1906, a specimen was taken in 43 fathoms off Souter Point. It measured $4\frac{3}{4}$ inches in length, and is figured by Meek in Northumberland Sea Fisheries Report for 1907.



Red Gurnard. 711



THE ARMED BULLHEADS or POGGES (Cataphracti).

The Armed Bullheads are marine fishes of small size and largely coastal in their habits. The body is elongate and sub-cylindrical. The teeth are minute. The ventral fins are under the throat. The body is covered with bony plates or scales. The family is represented in British waters by two species, belonging to different genera. These are the Armed Bullhead (*Agonus cataphractus*) and *Peristethus cataphractus*. A third member of the family, the Flying Gurnard (*Cephalacanthus volitans*) probably pays occasional visits to the Channel; it is, strictly speaking, a tropical species.

The British representatives of the Cataphracti may be distinguished by:

Small fishes. Head and body covered with bony plates.

No pectoral appendages. 1. *Agonus*.

Peculiarly shaped fishes. Pre-orbital bone prolonged into long flat process projecting beyond snout. Two free pectoral appendages. 2. *Peristethus*.

Long spine on shoulder and on angle of pre-operculum. Pectoral fin very long and used for flying.

3. *Dactylopterus*.

The Armed Bullhead (*Agonus cataphractus*).

The Armed Bullhead (Plate 25) has the head and body angular, and covered with bony plates. There are two dorsal fins, and no pectorals. The teeth in the jaws are small.

The Pogge, as it is sometimes called, has a wide distribution in the North Atlantic, being found in Greenland, Iceland, The Faroes, Barents Sea, White Sea, North Sea, Baltic and all round the coasts of the British Isles to the Channel. It is a typically northern fish.

One of the commonest of our shore fishes, the spawning

habits of the Armed Bullhead are now well known. The eggs are demersal, and may be laid either close inshore or right out at sea. Masses of eggs are most commonly seen attached to the "roots" of seaweeds, especially those species which flourish at low-water mark (Plate 14). The eggs have been discovered at St. Andrews as early as the beginning of October. The egg-masses are straw-coloured, and the number of eggs laid by one fish may amount to three thousand. Each separate egg-mass is small. The eggs are from 1·7 to 1·9 millimetres in diameter; the yolk is light orange-yellow and contains a large oil-globule. Hatching takes place from January to April, and the incubation period is therefore a long one. McIntosh records eggs being in water which became frozen in January and February, and yet the young fish were successfully hatched in March. He says that "the remarkable hardihood of such eggs is in contrast with pelagic ova, which, as a rule, would have been killed." While it is likely that demersal eggs can withstand greater environmental changes than pelagic eggs, the writer has collected pelagic eggs of the Plaice with a tow-net in the Baltic when, in order to lower the tow-net, the steamer had to be backed astern to make a suitable space in the thin ice which then covered the surface.

The egg-capsule of the Armed Bullhead is tough and rebounds from the needle under pressure like a ball of india-rubber. The larvæ are of pelagic habit and are widely distributed in the North Sea. They remain floating in the upper layers of sea water for about three or four months. According to McIntosh the larvæ appear to diminish in size as they get older. On attaining a length of 2 centimetres they become demersal, and by this time they have assumed the characters of the adult. The Armed Bullhead, like many coastal fishes, performs a seasonal migration. It is found in the coastal region in shallow water in summer; in winter the fish leave the coast for deep water.

The Armed Gurnard (*Peristethus cataphractus*).

A fish of very singular appearance, the Armed Gurnard, or Mailed Gurnard, is a native of the Mediterranean and warmer parts of the Atlantic. It is a fish of small size and deep-water habits, and as it in any case is only an occasional wanderer to our shores, the number of recorded specimens from British waters is very small, Day giving four only. In this species the head is parallelepiped, the sides and upper surface entirely protected by a bony armour. The pre-orbital is produced anteriorly into a flat process projecting beyond the snout. The body is covered with bony, scale-like plates. There are one or more barbels on the lower jaw. In section the body is octagonal. Nothing is known of its habits and development.

PEDICULATI.**The Angler or Frog-fish** (*Lophius piscatorius*).

This fish, which is known to our deep-sea fishermen as the Monk-fish, has a remarkable appearance (Plate 18). The head is large, being broader than it is long, while the body is short and tapering. The mouth is very wide, the lower jaw protruding. There are two rows of sharp teeth in each jaw, directed backwards and movable. The most peculiar feature of this fish is that the first dorsal fin consists of a few long separate rays, the first of which terminates in a flap of skin, and this ray, which can be raised or lowered at will, is said to be suspended over the cavernous mouth of the fish, where it is dangled as a bait. Any other fish which is incautious enough to approach this bait is immediately snapped up into the enormous mouth. Hence the popular name of "Angler" which has been applied to this fish. Whether there is anything really sufficiently attractive in the flap of skin attached to the

first dorsal fin ray, to make it useful as a "bait" for other fish, is doubtful. But anything moving in the water will attract fish that hunt by sight, so that doubtless this flap of skin does attract other fish and so may serve the same purpose as bait. Any fish swimming near the ground is liable to touch the tentacle of an Angler, which cannot be distinguished from a frond of seaweed or a zoophyte, and to touch it certainly means sudden death. The Angler ranges from the Shetlands to the Mediterranean, and though formerly regarded as worthless it is now marketed by the trawlers. As it is not attractive in appearance, the head is cut off and the skin removed from the flesh, when the fish finds a ready sale. The Angler is a medium-water fish of Atlantic habitat, preferring a muddy or shelly bottom. The average annual catch of British fishermen is from 1800 to 2000 tons.

The Angler is also remarkable for the nature of its spawn, which consists of a floating sheet of mucus from 1 to 3 feet in breadth and from 20 to 50 feet long. This spawn has been discovered off the American coast; in Scotland in the Firth of Forth; and in England off Mevagissey in Cornwall, where it was taken by Dunn. He saw it from the cliffs as a dark patch on the water, and the next day, taking a boat, he found and brought it ashore. It was far advanced in development, and the young fish, being black in it, could be seen "like currants in a cake," struggling to get out. The sheet of spawn consists of about 1,345,000 eggs embedded in a mass of mucus. The eggs are pear-shaped and attached to the inner surface of the roe by the narrow end. The eggs are rather large, $\frac{7}{100}$ of an inch in diameter. The sheet of spawn is due to the fact that the outer surface of the egg-membranes are jelly-like and sticky, so that they become attached to one another before leaving the roe of the mother. Each egg has a single large oil-globule situate at the hinder end of the yolk sac; the yolk is unsegmented. The larva, even before it leaves the egg, develops a large quantity



R. CLAVATA I.
THORNBAC

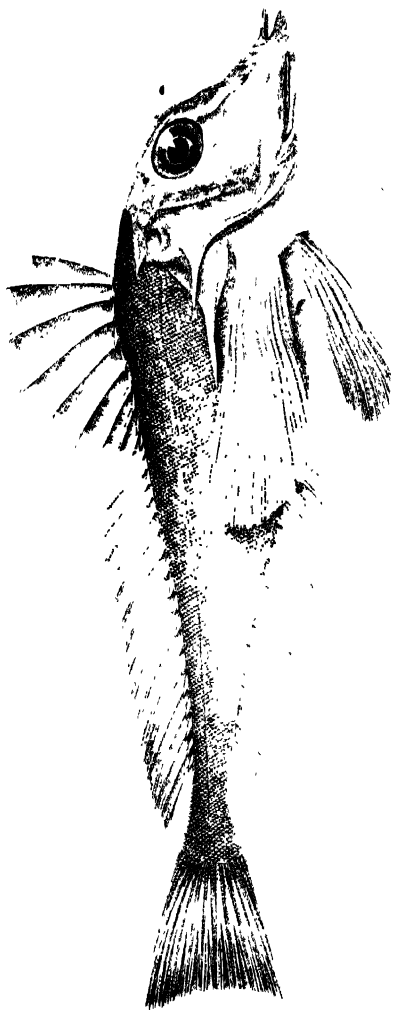
Egg capsule (with young) of Thornback Ray. (p. 323)



17 14

Eggs of Armed Bullhead. (p. 50)

E 58.



The Piper,
Lesser Weaver.

of black pigment, though the yolk and the substance of the body are quite transparent. The larva when hatched is much more advanced in development than is the case of those fish with separate floating eggs. The mouth is open and the yolk much reduced. There is also present just behind the head a short thick tentacle arising from a protuberance of the body. Thus early the tentacular fishing fin ray begins to appear.

TRACHINIDÆ.

The Greater Weever (*Trachinus draco*).

The Greater Weever (Plate 3) is a much rarer fish in British waters than the Lesser Weever. Its distribution is much the same as the smaller species, but rather wider, since it ranges from the Black Sea to Norway and the Baltic. The Greater Weever resembles the Lesser in appearance, except that it is larger, the body a deeper yellow, with several oblique bands on the sides. Both the Weevers have poison glands at the base of the dorsal fin. The Greater Weever lives in deeper water and is very rarely taken close inshore, at any rate on the west coast. It is occasionally trawled in Cardigan Bay, and the records are fairly numerous, commencing with five specimens caught in April, 1908, off New Quay Head. There is also a record of one specimen from the Mersey estuary.

Its breeding habits are similar to those of the Lesser Weever, though its egg is smaller, measuring only 0·94 to 1·11 millimetres. These eggs are found in the North Sea from June to August, and are easily distinguished from those of the Lesser Weever, not only on account of the smaller size but by the presence of a conspicuous oil-globule, which is usually colourless but may be tinged with yellow. The young larva hatches out in summer in from four to five days. The life-history is similar to that of the Lesser Weever. The Greater Weever, however,

attains a length of 17 inches. The largest hitherto recorded in British waters was 17½ inches long, a female landed at Plymouth on the 20th November, 1897 (Holt).

The Lesser Weever (*Trachinus vipera*).

One of the commonest fish met with in our shrimpers' trawl nets, the Lesser Weever (Plate 15) is distinguished by the cleft of the mouth pointing obliquely upwards; by the two dorsal fins, the first consisting of five spines, the second, much longer, of twenty-one to twenty-four rays; by the very small cycloid scales and the small conical teeth. The back is grey, paler underneath; the first dorsal fin black.

The Lesser Weever, or Sting-fish, is one of the very few fish provided with poison glands. The dorsal fin spines are grooved and erect; a large spine on the operculum is also grooved. The grooves on the opercular spine are dorsal and ventral, those on the fin lateral. Along these grooves and at the bases of the spines are poison glands, masses of glandular cells without ducts or follicles. The integument covers the gland cells and all but a portion of the point of the spine.

The fish often buries itself in the sand, only the top of the head with the eyes and mouth and the tip of the dorsal spines protruding at the surface.

The diet of the Weever consists of shrimps.

The sting of the Weever is extremely painful and is much dreaded by shrimpers, who exercise great care in riddling and sorting their shrimps when this fish is present, as it usually is.

The Sting-fish is of wide distribution, ranging from the North Sea to the Mediterranean. In the southern sandy shallow waters of the North Sea and on the Lancashire shrimping grounds it is particularly abundant. A shallow-water species, it spends the whole of its life near the coast.

The spawning period is from May to September. The eggs are found every year in shallow water near the coast;

they are of the pelagic type, measuring from 1'10 to 1'37 millimetres in diameter, and are distinguished by a number of pale yellow oil-globules. In summer the young fish hatches out in from nine to ten days. This species attains a length of 6 inches.

THE MACKEREL FAMILY (*Scombridæ*).

The Mackerels are fish with an oblong, scarcely compressed body, which may be either naked or covered with scales. The eye is lateral, the gill openings wide. Teeth are present in both jaws, but may be absent from the palate. There are two dorsal fins, the first spiny, distinct from the second. There are finlets present. The pelvic fins are thoracic, with one spine and five rays. The side of the tail is sometimes keeled.

The "Mackerels" found in British waters may be divided by the following characters:—

Five or six finlets; scales equally covering the whole body;
two slight ridges on each side of tail.

Scales not enlarged in pectoral region.

The Mackerel (*Scomber scombrus*).

Scales enlarged in pectoral region, forming a corslet.

The Spanish Mackerel (*Scomber colias*).

Six to nine finlets; scales of pectoral region forming a corslet or keel on each side of tail; teeth rather small, teeth on palate and vomer.

Pectoral fin short, about $\frac{2}{11}$ length of fish.

The Tunny (*Thynnus thynnus* or *Orcynus thynnus*).

Pectoral fin long, about $\frac{1}{3}$ length of fish.

Long-finned Tunny (*Thynnus germon* or *Orcynus germon*).

Pectoral fin short, 4 to 6 blue bands along side of body.

Bonito (*Thynnus pelamys*).

Seven to nine finlets (6); scales of pectoral region forming a corslet; a keel on each side of tail; teeth moderately

strong, teeth on palate; narrow oblique bands on upper surface of body. Pelamid (*Pelamys sarda*).

Seven to nine finlets; scales of pectoral region forming a corslet; a keel on each side of tail; teeth very small, none on palate; no bands on body.

Plain bonito (*Auxis rochei*).

The spinous dorsal modified to a sucking organ, situated on the head. Remora (*Echeneis remora*).

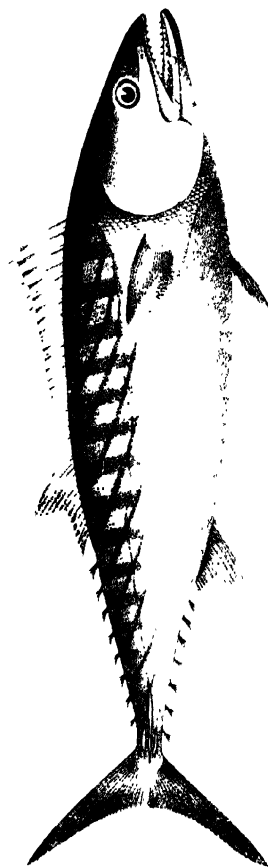
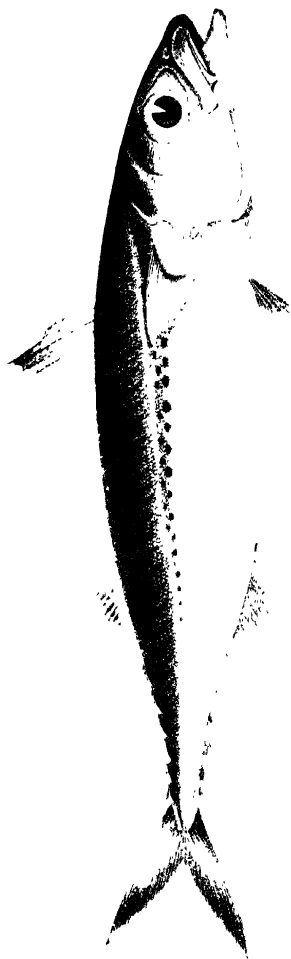
The Mackerel (*Scomber scombrus*).

The Mackerel (Plate 21) ranges from the south of Norway to the Canary Isles. Varieties are sometimes met with in which there are small black spots or irregular scribbled lines instead of the usual wavy bands. The Mackerel is a pelagic or surface fish and lives on the small crustacea and other organisms which drift about in the upper layers of the sea (Plate 68), and hence is spoken of as a plankton feeder.

The female Mackerel produces from 400,000 to 500,000 eggs.

Spawning takes place in the summer at the surface at a short distance from land, from 14 to 50 miles distant. The eggs of the Mackerel are heavier than those of the Lemon Sole, and though they float at first, after about two days they sink to mid water, where they remain suspended for a short time, ultimately finding their way to the bottom. At a temperature of 58° F. the period of incubation is six days. The egg is globular and transparent, the yolk simple and provided with a single large oil-globule. It is not quite $\frac{1}{20}$ inch in diameter.

Artificial hatching of this fish is extensively carried on in the United States. The newly hatched larva is $\frac{1}{10}$ inch long. After about nine days the yolk is absorbed and the young fish hunts for its food. The Mackerel matures at a length of 12 inches, when it is from three to four years old. It is a



Pl. 10.

Spanish Mackerel. *Scomberomorus commerson*
Pelamid.

L. 62



E 63.

Grey Gurnard. (p. 52)
Streaked Gurnard. (p. 53)

migratory fish ; it moves offshore in winter, probably going down to warmer and deeper water quite close to the coast.

On the west coast, mackerel approach the land in May when the spawning season commences, and leave it again in the early autumn when the spawning season is over. It is a belief among fishermen that the first mackerel of the season are blind, having a cloudy film of skin over the eyes, and that this film disappears in the summer. The fishermen substantiate this by pointing out that the mackerel only take bait in the summer. Personally I have not seen anything to support this belief, though I have examined numerous mackerel at all times of the year. Bait fishing with hook and line is only followed in summer because it is generally practised in small open or half-decked boats near the shore. Certainly the fish bite more readily after the end of June because in the spawning season they take less food, the females for a time even abstaining altogether.

The Spanish Mackerel (*Scomber colias*).

Apart from the Common Mackerel, the members of the Mackerel family, including the Tunnies, are rare visitors to our coasts. Normally inhabitants of sub-tropical waters they occasionally stray, owing to their wandering habits, into British waters. Although the Common Mackerel spawns in British seas and even farther north, its egg being first described by the Norwegian naturalist G. O. Sars in 1879, it is doubtful whether the Spanish Mackerel spawns in our area. In fact, apart from the Common Mackerel, very little or nothing is known of the spawning habits, eggs and young of the other members of the family.

The Spanish Mackerel (Plate 16) is most readily distinguished from the Common Mackerel by the presence of a corslet of large scales in front of and below the pectoral fin. This corslet is even more marked in the Tunnies.

The Spanish Mackerel has a wide distribution. It is an

Atlantic and Mediterranean species, ranging north to England and Ireland. It is found on the American coast, and in the Pacific, tropical American, Japanese and Australian waters.

According to Couch the Spanish Mackerel is not uncommon off the Cornish coast ; in certain seasons hundreds are seen at a time. Farther north it is much rarer, and there is no positive record of its occurrence in the Irish Sea.

The Tunny (*Thunnus thynnus*).

The Tunny (Plate 19) is a southern and Mediterranean species ; like the Spanish Mackerel it occasionally wanders into British waters, and like the other members of the Scombridæ its migration northwards is in the summer-time. Occasionally shoals of Tunny have been seen in the North Sea in autumn, and they even stray into the Baltic, where a very large specimen was washed ashore at Travemunde in 1903. The Tunny differs from the Mackerel (*Scomber*) in having a longitudinal keel on either side of the free portion of the tail ; the two dorsal fins are also placed close together ; the corslet is more developed and the dorsal fin elongated.

The Tunny is a predatory fish ; its eggs and young larvæ are unknown. The Tunny is perhaps the most important food fish found in the Mediterranean, and there has been an important fishery for it from time immemorial. There are very many references to the Tunny in the classics, and there can be little doubt that it played a part in the food-supply of the Greeks and Romans and other Mediterranean peoples similar to that of the Herring for northern folk. Thousands of poor people welcomed the Tunny as an important addition to their food. It was eaten both fresh and salted. Certain parts of the flesh, particularly the abdomen, were highly esteemed by connoisseurs and formed one of the most appreciated dainties of classical feasts. Many of the spices and sauces known to

the ancients were prepared from the gills and intestines of the Tunny. References to the occurrence of the Short-finned Tunny in British waters are fairly numerous. Pennant records a specimen taken at Inverary in 1769 weighing 460 lbs. Specimens range up to 900 lbs. in weight. In the Mediterranean it attains a much greater size, frequently to 1,000 lbs. weight, and, it is said, they run up to 1,800 lbs. in extreme cases.

The Long-finned Tunny (*Thynnus germon*).

The Long-finned Tunny, or Albacore (Plate 20), resembles its near relative the Short-finned Tunny in habits and distribution. It is easily distinguished by the great length of the pectoral fin, which is sickle-shaped and equal in length to about one-third of the total length of the fish.

It is widely distributed in the Mediterranean and Bay of Biscay, and is a voracious species, living on other pelagic fish.

There are four records of the capture of this species in British waters by Day, twice in Mount's Bay, Cornwall, off Portland, and a little way up the river Exe in Devonshire. Scharff records one caught off the Irish coast in the autumn of 1901, near Wexford. This specimen is 2 feet 7 inches long from the snout to the fork of the caudal, and has pectoral fins 11 inches long. It was coloured dark blue above and silvery-white below, and was the first recorded in Ireland. In 1914 another was found on the shore at Achill Island, and sent to the Irish National Museum. It was 2 feet long from the tip of the snout to the fork of the tail fin, the pectoral fin being 9 inches long.

Another specimen weighing 42 lbs. was captured by a herring boat off the Orkney Islands in June, 1900. The second Scottish record was from Loch Gilp in 1933. In June, 1934, a specimen 44 inches long, girth 31 inches with a pectoral fin of $16\frac{1}{2}$ inches, weighing 56 lbs. was captured in the River Echaig at the head of Holy Loch.

The Pelamid (*Pelamys sarda*).

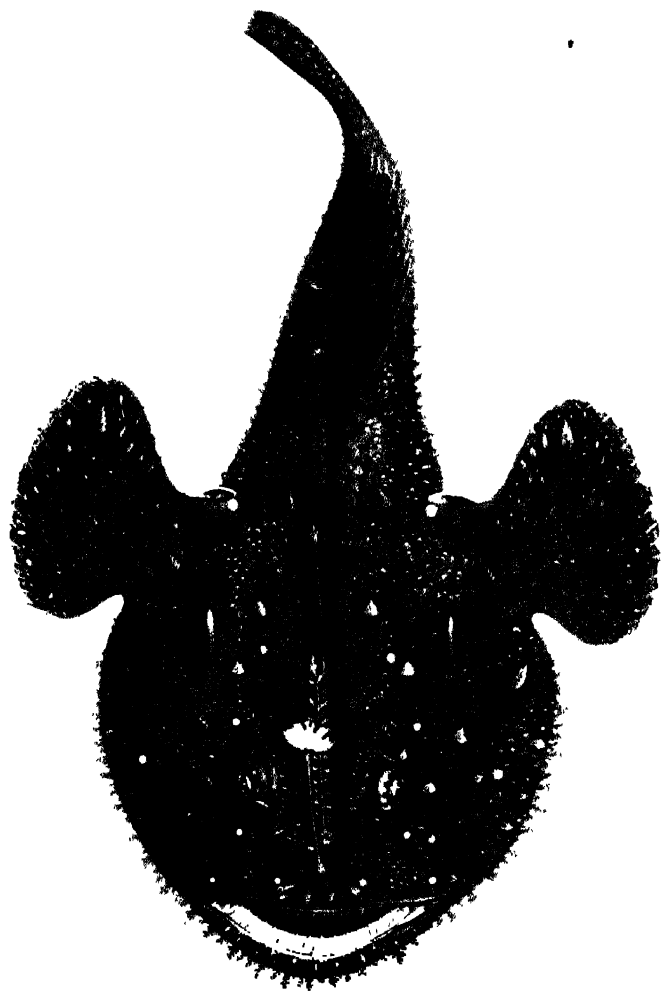
The Pelamid (Plate 16) is distinguished from the other Tunny-like fish met with in British waters by the peculiar banded appearance of the upper surface of the body. There is a series of broad bars on the upper half of the body reaching vertically down to just below the lateral line, and in addition a number of narrow dark oblique bands passing upwards and backwards to the back from the abdomen.

This fish, which is also called the Belted Bonito, is of wide distribution. It is found on both sides of the Atlantic, and is particularly abundant in the Mediterranean and tropical Atlantic. Day gives three records of this species in British waters, and then points out that in addition other examples of this fish have been captured but recorded under a wrong name, and it is quite possible that this fish has sometimes been mistaken for the Bonito or Striped-bellied Tunny (*Thynnus pelamys*). On the 20th June, 1896, a small specimen weighing 8 lbs. was captured in the Solway and presented to the Edinburgh Museum (Service); on the 7th July, 1893, a specimen 21 $\frac{3}{4}$ inches long was caught in the North Sea and landed in Scotland. In 1885 one was caught at Buddon, Montrose, and is now in the Museum there (Sim). Storrow records a specimen caught near Holy Island between Parton Steel and Budle Bay in August, 1925; also at Houth, Co. Dublin, in July, 1923.

Nothing is known of the breeding habits of this species, but it probably produces a similar pelagic egg to that of other species of the Mackerel family.

The Bonito (*Pelamys thynnus*).

The Bonito, or Striped-bellied Tunny, is a smaller form than either of the two preceding species of Tunny. It may be distinguished from them by the toothless vomer, by its having





no scales apart from the corslet, and by the four, five or six concave, longitudinal bluish bands which run along the side of the body and the abdomen, ending posteriorly on the lateral line or close to the finlets.

The Bonito occurs in the Mediterranean and in warmer parts of the Atlantic.

Day gives four certain records in British waters; at St. Andrew's in Scotland, at Plymouth in a trammel net, and two instances in the Irish Sea, one at Whitehaven, the other, 2 feet long and weighing 6½ lbs., at Hawgill in the Solway Firth. According to Service there are three additional records for the Solway Firth: in July, 1831; July, 1842; and in 1893. On the Yorkshire coast two specimens have been taken at Whitby, one in 1882; the other, 22 inches long, in August, 1922 (Wilson).

The Bonito has also been taken at Clifden, County Galway, whence the Irish National Museum specimen was obtained. An additional record for the Irish Sea was obtained in August, 1924 (White), a specimen 2 feet long and weighing 10 lbs. being captured in the Menai Straits near the Menai Bridge gasworks.

The Plain Bonito (*Auxis rochei*).

The Plain Bonito is very similar in appearance to the Mackerel, though it is rather a larger species. It may be distinguished from the Mackerel by the corslet and from Thynnus and Pelamys by having no palatine teeth, there being teeth in the jaws only.

This surface-living member of the Scombridæ ranges from Norway to the Mediterranean and Jamaica. It is a very rare visitor to British waters. Day gives about half a dozen records, mostly from our southern coasts.

The Remora (*Echeneis remora*).

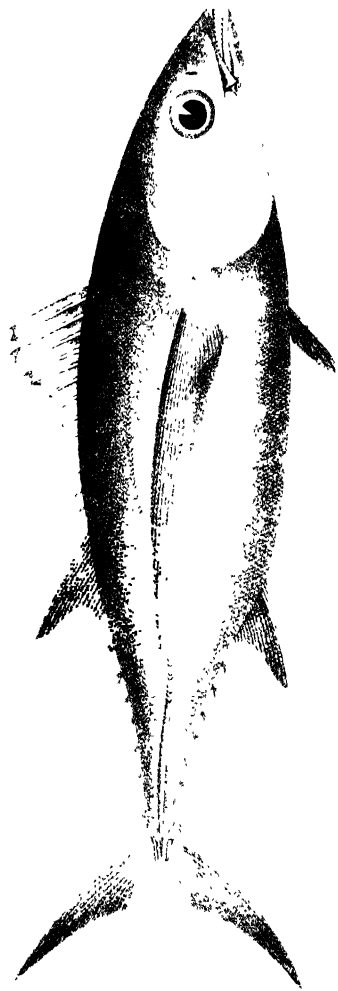
The Remora, Sucking-fish or Sucker (Plate 24), has the head depressed and the body covered with minute scales. The great peculiarity of this fish is that the anterior dorsal fin is modified to form an adhesive disc which occupies the upper part of the head and neck. The anterior dorsal spines are composed of two parts, each half being bent down to right and left, thus forming a support for a double series of transverse lamellæ with rough edges. The complete disc is oval in shape and surrounded by a membranous fringe. By means of this disc the fish is able to attach itself to any flat surface, such as the skin of a shark or the bottom of a ship, the whole apparatus acting as a sucker. In this way the fish is carried long distances, and so, although not a British species, it is not infrequently captured in British waters. This fish was well known to the ancients, and is mentioned by many classical authors, including Aristotle. Many fables have been related about this fish, especially one which states that it is able to stop vessels on their course.

Several species are known in tropical seas, of which the above has been recorded in our waters. The number of lamellæ, varying from 12 to 27 pairs, serves to distinguish the different species.

Nothing is known of its spawning habits.

THE BLACK FISHES (Stromateidæ).

The Stromateids are marine and surface-living fish allied to the Mackerels. The body is compressed and more or less elevated, covered with very small cycloid scales. The dentition is feeble, there being no bones on the vomer or palatines. There is a single dorsal fin, which is long and has no spinous



Long finned Tunny.



Mackerel. (p. 62)

division. A peculiarity of this family is that the œsophagus is armed with numerous horny, barbed or hooked teeth.

There are four British members of the Stromateidæ, which are thus distinguished :

Caudal forked. Pre-opercle margin smooth or slightly serrate.

Dorsal fin long, about six-elevenths of body length.

The Cornish Black-fish (*Centrolophus britannicus*).

Dorsal fin shorter, about one-third of body length.

The Black-fish (*Centrolophus pompilus*, Day, or *C. niger*, Gm.).

Caudal rounded. Pre-opercular margin spiny.

Dorsal spines not distinct. Scales about 140.

The Portrush Barrel-fish (*Lirus medusophagus*).

Caudal forked. Dorsal spines distinct, shorter than soft rays and eight in number. Scales 80-90.

The Barrel-fish (*Lirus perciformis*, Mit.).

The Black-fish (*Centrolophus niger*).

The species of Black-fish (*Centrolophus*) are distinguished from the Barrel-fish (*Lirus*) by their elongated body and by the dorsal and anal spines being slender, indistinct and graduating to the soft rays.

The Black-fish has a moderately stout and subfusiform body (Plate 26). There are about three spines in the dorsal fin, indistinct and hardly piercing the skin. The bases of the dorsal and anal fins are marked by a fleshy scale-clad sheath, from which scales extend along the rays almost to their extremities. The colour is usually purplish or violet-black, grey on the head and paler on the abdomen, sometimes with indistinct spots or marblings. This species attains a length of 3 feet.

It is a surface-living fish of the eastern Atlantic and Mediterranean. According to Holt it is probably not uncommon on

the offshore grounds at the mouth of the English Channel and on the west and south of Ireland, but is rarely recorded except when it follows drifting wreckage or ships into shallow water. Holt records it from Inisbofin, County Galway; Port Salen, County Donegal; and from the Scilly Isles. Four specimens from 12 to 13 inches long were obtained by a mackerel boat fishing off the Runnistone in June, 1891. It also occurs in the North Sea as far north as Aberdeen. The earliest record for Scotland is of a fish obtained at Lossiemouth in 1841. This specimen was 14 inches in length and almost wholly black. Another specimen was caught 20 miles offshore from Aberdeen in April, 1887; this fish measured $23\frac{1}{2}$ inches in length (Sim). In August, 1901, another was taken in a salmon net at Largo Bay, Firth of Forth, and presented to the Edinburgh Museum. This fish was $20\frac{1}{2}$ inches long, elegantly fusiform in shape and tapering posteriorly. The colour of the stuffed fish is uniform dark brown, which was most probably nearly black when the fish was alive. Another specimen was obtained at Palling near Yarmouth, in March, 1900; also off Valencia, Co. Kerry, May, 1931 (Miss M. J. Delap) and eleven specimens, Irish Atlantic Slope, Fraser-Brunner, 1934. There is no definite information as to the habits, breeding or food of this species. The young have been found feeding on young pollack.

A closely allied form, the Cornish Black-fish (*C. britannicus*), is known from a single specimen which came ashore at Polperro, Cornwall, in 1859, and is now in the British Museum. Tate Regan regards it as a distinct species differing from the above in the more elongate form, the large number of dorsal and anal fin rays, and the shorter curve of the lateral line.

The Barrel-fish (*Leirus perciformis*).

In this species (Plate 27) the dorsal spines are distinct, much shorter than the soft rays and eight in number. The body is stout,

ovate and compressed, with the snout obtuse. The caudal peduncle is one-fifth of the total length. The bases of the dorsal and anal fins are concealed in a fleshy scale-clad sheath. The coloration is uniform purplish-black, somewhat paler on the body. The Barrel-fish attains a length of at least 13 inches. It is a surface-living species of the temperate North Atlantic, not uncommon on the American coast, where it is occasionally fished for, as it is a good tasty fish. Its most remarkable habit is that it follows any floating object, such as a log, for the sake of the barnacles adherent to it. The Barrel-fish, Log-fish, Rudder-fish or Black Rudder-fish, as it is variously called, secretes itself in floating barrels or boxes. According to Holt, every case of its occurrence on the coasts of Ireland can be associated with an object presumably covered with barnacles. Its first occurrence in Irish waters was accidentally discovered by Holt when examining some fish in the collection of the Irish National Museum, when a specimen labelled "*Centrolophus pompilus*, Dingle Bay, presented by William Andrews, 1871" was found to be a Barrel-fish (*Leirus perciformis*). It was one of a shoal found swimming over a piece of floating wreck.

Another specimen was captured off Penzance in October, 1874, drifting in a broken fish-box, from which it was unable to escape, its food being the barnacles growing on the box. In September, 1901, a large shoal followed a barnacle-covered log ashore at South Island, Aran Islands, under the following circumstances as detailed by Costello :—

" They came after a log of timber covered with barnacles, and were thrown ashore at the north-west corner of the South Island, where the Congested Districts Board is after building a breakwater and clearing the shore. At the time, owing to the tide being low, it was like a horseshoe, so that if the islanders took 20 fathoms of net and put it across the entrance they would save thousands upon thousands of fish ; but, instead of that, when they saw the fish, from a high ledge on one side, having

the barnacles like the calf would have the teat of a cow in its mouth, they all got afraid, and said they were Sheeogues (little fairies), and then ran away, except one old man.

"At the time the log struck the shore about 400 of the fish jumped on dry land, and were hopping about on the shore, so that some of them got into the water again, while others died and were carried away by the next tide, except two that the old man took home with him.

"When the old man came home and his wife and sons saw the fish they would not allow him to take them into the house, as they 'never saw the like before; they were no fish, but Sheeogues resembling fish.' It was from this man that Mr. Costello got them.

"When the log dried it appears the fish turned away to sea and scattered about. A man named —, with another, was fishing half a mile from the shore in a canoe, with hand lines, a few days after, and was looking out over the side, as the day was bright, and saw one of these fish swimming about very near the surface. He pulled ashore, and did not go out again for three days."

This species is the same as that described by Day as *Pammelas perciformis*, or Black Pilot-fish. At the time when Day wrote only one specimen had been recorded from British coasts; this was the specimen referred to above, captured by the crew of a trawler in a floating wooden case 6 miles off Penzance.

The Portrush Barrel-fish (*Leirus medusophagus*).

This species is of extreme rarity in British or Irish waters, only one example having been recorded up to the present.

Leirus medusophagus (Plate 23) is a surface-living fish with a moderately stout, ovate and strongly compressed body in which both the skeleton and muscular tissues are very soft. The dorsal spines, which are soft and weak, are connected with one another and with the soft rays by membrane. The colour

is pale olive-green with darker marblings; the vertical fins have blackish spots. Like other members of the family, this fish seems to prefer to live in the neighbourhood of floating objects such as large jelly-fish, or weed or wreckage, apparently for the purpose of feeding on the small organisms accompanying such flotsam. Its association with jellyfish has given it the specific name of "*medusophagus*."

The solitary record is of a specimen captured in a salmon net at Portrush in 1878; it seems to have followed shoals of herring-fry, on which it was feeding, into the bay.

The so-called "DOLPHINS" (*Coryphænoididæ*).

The *Coryphænidæ* are tropical and sub-tropical fish of pelagic or surface-swimming habits. They are large and handsome fish, swimming in shoals, and in the old sailing-ship days were frequently taken by hook and line by our sailors, who mis-named them "Dolphins"; the real Dolphin is of course a cetacean, that is, not a fish at all, but a mammal. The fish to which the name of Dolphin has thus been most commonly, though erroneously, given is *Coryphæna hippurus*, not a British species, though abundant enough in the Mediterranean. In this family the body is compressed, the gill openings are wide and the eyes lateral. The teeth in the jaws are small; they may be present or absent on the palate. The single dorsal fin is long, without any distinct spinous division. The ventral fins are thoracic in position. The members of this family, which are rare visitors to British waters, are of bizarre appearance and brilliant coloration.

Four species belonging to three different genera have been certainly recognised as British. They may be distinguished by the following characters:—

Pelvic fins thoracic, one-fifth. Dorsal commencing on back.
Scales rather small. Pre-operculum entire.

Ray's Bream (*Brama raii*),

Dorsal and anal fins much elongated.

• Long-finned Bream (*Brama longipinnis*).

Pelvic fins thoracic, rudimentary. Dorsal occupies the posterior half of the back. *Luvarus imperialis*.

Pelvics many-rayed and elongated.

Opah or Sun-fish (*Lampris luna*).

Ray's Bream (*Brama raii*).

The Black Sea Bream, or Ray's Bream (Plate 22), formerly classed in the family Coryphænidæ, is now generally included in a separate family, the Bramidæ, which is composed of deep-sea fishes of wide distribution. Of this family two genera are found in northern waters, one of which, *Brama raii*, is British.

It is a fish of characteristic appearance, with a body elevated and compressed, and a very long dorsal fin composed of three or four spines and many rays. The whole surface of the head and body is covered with scales. The cleft of the mouth is oblique, the lower jaw being the longer. There is an outer row of pointed teeth some distance apart in the upper jaw; in the lower jaw one or two rows of conical, pointed, rather curved teeth.

A fish of very wide distribution, extending from Norway and the Faroes to the Cape. It is common in the Mediterranean, and is also found on the western side of the Atlantic and is not uncommon in British waters. It has been established that this fish makes an annual migration to British waters, even to the east coast, and it has been captured in the Firth of Forth on several occasions. It spawns to the south of the Equator, where young specimens less than 2 centimetres in length have been taken. Storrow records one from Blyth Bay, November, 1924. Length 2 feet, weight 6 lbs. 6 ozs. In November, 1927, four were taken near Cromer. A very large number entered the North Sea in the last three months of 1927 (Clarke).

The Long-finned Bream (*Brama longipinnis*).

The first record of this fish in the British, or rather Irish, fauna dates from the 18th May, 1914, when a specimen was captured by a lobster fisherman with a gaff off the west coast of Valencia Island. The fish was sent to the Dublin Museum and found to be new to the Britannic Fauna. It was subsequently taken to the British Museum, and there the identification was confirmed and the fish proved to be the Long-finned Bream. This species is especially noteworthy by the elongated dorsal and anal fins. The dorsal fin arises behind the direct line above the insertion of the pectoral. The front of the anal fin lies about the middle of the body. The scales near the forked tail are provided with a tiny hook. In its living condition the fish is brilliantly coloured, but on arrival at Dublin it was almost uniformly grey. The specimen which is described and figured by Scharff in the "Irish Naturalist" for 1915 is 20 inches long. The Long-finned Bream was originally described from Madeira, but specimens have also been obtained from the north coast of Norway and from Iceland, so the species is of wide distribution.

Luvarus (*Luvarus imperialis*).

Luvarus is a pelagic species allied to the Mackerel; for convenience it is included here in the Coryphænidae, though some zoologists put it in a separate family, the *Luvaridae*.

Luvarus is a large fish (Plate 24) of pelagic habits, found in the Mediterranean and warmer parts of the Atlantic and only rarely visiting our shores. A fish of striking appearance, Luvarus is easily identified. The body is oblong, enlarged anteriorly, but dwindling much in size and compressed posteriorly. The mouth is terminal and very small. A single-rayed dorsal fin is situated in the last half of the back, and

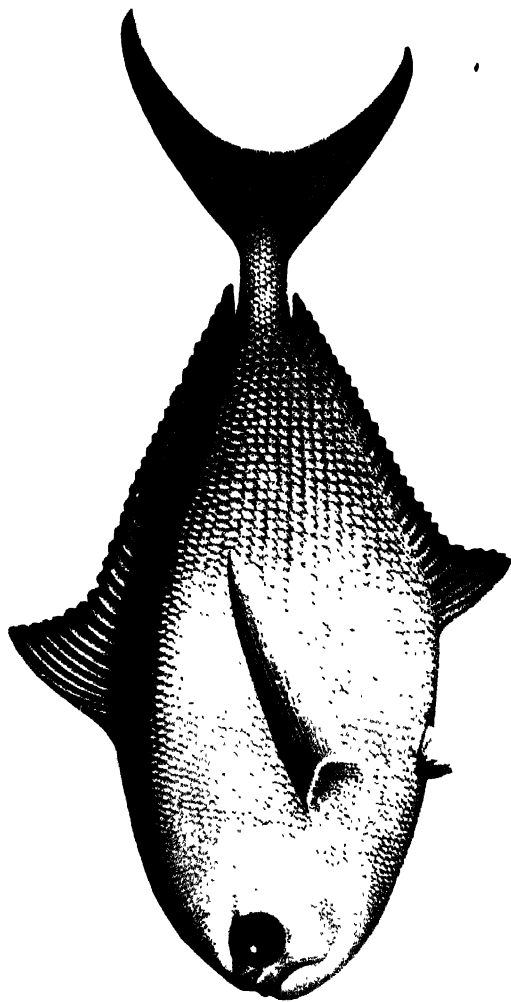
opposite it there is a very similar anal fin. The pelvics are thoracic in position.

Day records only two specimens of this species, both from Cornwall. Since then there are several records. One was taken at Seven Heads, County Cork, Ireland, in 1901 (Scharff); another was recorded by Boulenger from St. Mary's, Guernsey, in 1902; and a third, 4 feet 3 inches in length and weighing about a hundredweight, was taken in Walker's Bay, Killibegs, in September, 1910 (Constable). The Luvarus recorded by Scharff in 1901 was the first from Irish waters. A fine specimen, about 4 feet 6 inches long, weighing about $1\frac{1}{2}$ cwt., it was coloured metallic ruddy orange, lighter underneath; the tail and lateral fins were bright scarlet, almost vermilion.

The Luvarus is such a striking, rare and handsome fish that its occurrence is hardly likely to be overlooked, so it must be an exceedingly rare visitor to British waters. Its habits are unknown.

The Opah (*Lampris luna*).

The Opah, Sun-fish, King-fish, or Jerusalem Haddock, is one of the most handsome fish encountered in British waters. A deep-sea fish of the Atlantic, it wanders not infrequently into our waters. Attaining a length of 4 feet the Opah is a fish of striking appearance and beautiful coloration. The body is oval, elevated and compressed, bluish on the back, with large round silvery spots, red beneath, the fins deep scarlet. The general colours vary from silvery green to bright golden with azure reflections. The dorsal fin is long with the first portion elongated, the remainder of the rays being short. The pectoral is falciform, the pelvics situated rather behind the insertion of the pectoral but similar in shape. Lateral line conspicuous, with a strong curve, formed of single unbranched tube. The Opah is a pelagic species, ranging from Madeira and Teneriffe northwards to Newfoundland, Iceland and Finland.



Ray's Bream p. 74



Day gives quite a number of references from practically all parts of the British and Irish coasts. In June, 1906, a fine specimen 3 feet 7 inches long and 2 feet high was stranded by the tide on Lambay Island and is now in the Dublin Museum, where there are also specimens from the coasts of Galway and Wexford. According to Scharff there are seven previous records from Ireland, of which three were from the north. In October, 1891, a King-fish or Opah was taken at Yarmouth measuring 38 inches in length and 41 in girth, weight 51 lbs. (Patterson). Fulton gives several references to this species in Scottish waters, including a female captured on the 18th October, 1901, off the Shetlands, which had nearly ripe eggs in the ovaries. These eggs would appear to be of the pelagic type. Another specimen was taken at Aberdour in October, 1890, and one 4 feet long, weighing 103 lbs., at North Queensferry in July, 1898 (Clarke). Another was taken in September, 1900, on the shore at Sumburgh, West Voe (Shetlands); and the long liners fishing these waters say that in September every year when they are fishing to the west of the Shetlands rarely a week passes without King-fish being taken.

Additional Scottish records are: Three from the Orkneys in June, 1901; in July, ten from different parts of Scotland; in August, one from Foula; in September, two from Hoy; all taken by line. One taken off Scalloway in October was 3½ feet long, 22½ inches deep, and weighing 85 lbs. (Fulton).

A specimen 3 feet long was landed at North Shields in July, 1924; another 3 feet long and weighing 44 lbs. was caught at Whitley Bay in September, 1924 (Storow).

THE HORSE MACKERELS (*Carangidæ*).

The Horse Mackerels are surface-living inhabitants of tropical and sub-tropical waters, a few species of which are



Pl. 24.

Remora. Pl. 24.
Luvapus. Pl. 24.

Pl. 24.



The Horse Mackerel approaches our shores in early summer for spawning purposes. Large shoals have occasionally been encountered off our western and south-western coasts, but farther north it is by no means a common fish. The writer has taken occasional specimens in the trawl in the Irish Sea; for instance, on the Lancashire fishery steamer in Redwharf Bay, Anglesea, in December, 1912; and Service records it from the Solway in 1899. Another specimen was stranded in the Solway at Sillloth in 1897. The Horse Mackerel spawns from June to August. The eggs are pelagic, measuring on the average 0·96 millimetre, with a reddish-tinted oil-globule. The larva is hatched out at a length of 2·5 millimetres. When about a centimetre long the fin rays are developed, and at this stage of their existence the young fish are frequently seen sheltering under large floating jelly-fish. There seems to be considerable variation in the extent of the northward migration of the Horse Mackerel in different years; sometimes it wanders right up to Trondhjem. Although it is rare in the North Sea north of Norfolk, according to Wollaston the eggs are common in the south-west part of the North Sea, so the fish unquestionably spawns there. There is another spawning area off the entrance of the English Channel, and young forms about 2½ centimetres long are common in inshore waters in Cornwall. The young fish evidently migrate offshore later in the year.

The Pilot Fish (*Naucrates ductor*).

The Pilot-fish (Plate 27) receives its name from its habit of accompanying ships and large fish such as sharks, and it has long been celebrated in stories as a guide and friend of the shark. A truly pelagic species, the Pilot-fish has an oblong, sub-cylindrical body with small scales. There are five or six dark green or blackish vertical bands on the body, the bands being narrower than the ground colour, which is bluish. The Pilot-fish, which is the *Pompilus* of the ancients, is of wide

distribution, extending from the British Isles through the Atlantic to tropical seas. Day gives about seventeen distinct records for its appearance in British waters, most of which are from the Cornish coast. In one instance he states that two of these fishes were caught in Falmouth Harbour in 1831, having accompanied a vessel thither for eighty days. Day gives one record for Irish waters; since his time there is only one additional record for Ireland. A specimen 13 inches long was taken in mackerel nets at Valentia Island, County Kerry, in July, 1903, and sent to the National Museum of Ireland. One specimen, Irish Atlantic Slope, 1934 (Fraser Brunner).

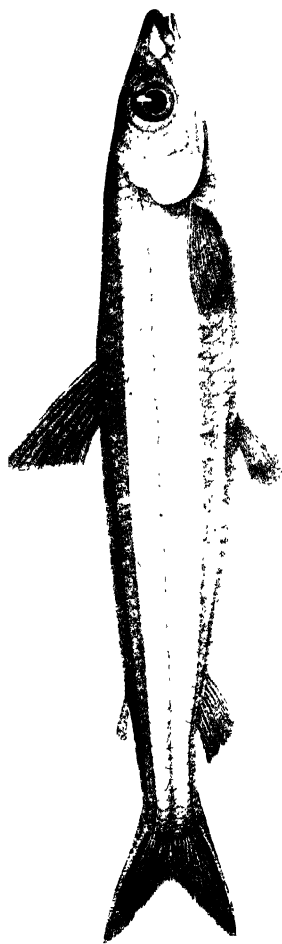
The Pilot-fish spawns in the open ocean. The young have long been known; at one time they were described as different genera, *Nauclerus* and *Xystophorus*.

It is a well-authenticated fact that the Pilot-fish accompanies the Shark, probably enjoying the protection afforded by his presence. The Shark does not attack the Pilot-fish, probably because the latter is too nimble or too small to serve as food for the Shark.

The Glaucus (*Lichia glauca*).

The Glaucus or Derby of Couch is so named from its light sea-green colour. A Mediterranean species it is extremely rare in British waters, Day giving only two records, both off the Cornish coast. The Glaucus may be identified by the fact that the first dorsal consists of three spines, the first being directed forwards. The second dorsal is low, and there are no finlets. The anal fin is similar to the first dorsal, and there are two pre-anal spines. Nothing appears to be known of its habits and development.

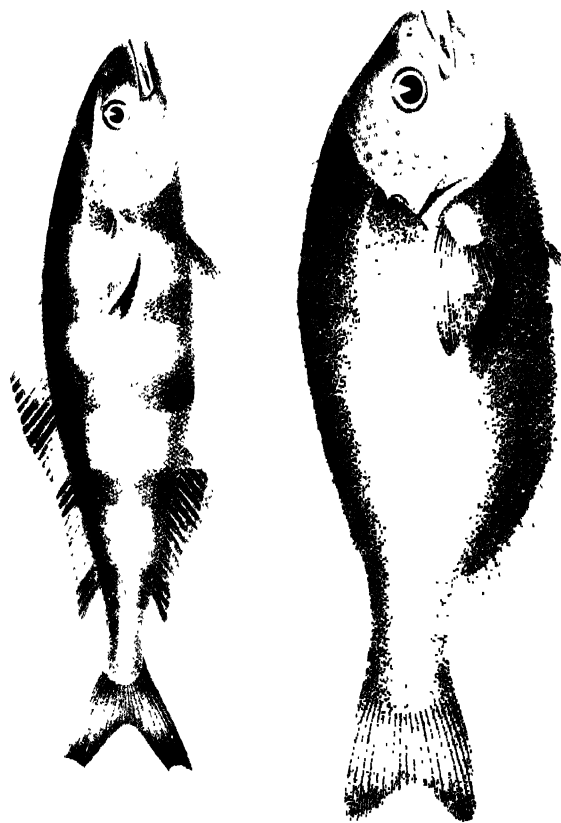
A second species of *Lichia*, namely *Lichia vadiago*, Risso, has been twice recorded in British waters. The first specimen was taken off Waternish, Isle of Skye, in the month of



180.

Argentine. (p. 25)
Black Fish. (p. 108)

P. 26.



Pilot Fish.
Barrel-fish or Black Pilot-fish (p. 70).

September, and another in August, 1892, in a Pollack net off Prussia Cove, Marazion. These fish were 20 and 19 inches long respectively. This species may be recognised by its coloration at a glance. It is shaped like a Horse Mackerel and has the upper part of the body greenish-black, the lower silvery, the two colours when they meet forming deep indentations by which they are dovetailed into one another.

The Boar-fish (*Capros aper*).

By some authorities the Boar-fish (Plate 28) is included in the Horse Mackerel family, by others it is placed in the same family as the John Dory, or even in a separate family, the Caproidæ. It certainly resembles the latter in some external features. The body is high and compressed, and as in the Dory the mouth is so constructed that it is very protractile, and when opened the upper jaw is thrust forward, the whole mouth forming a sort of tube. The scales are small but spiny, so that the skin feels rough. The first dorsal fin has nine spines, the anal three. In the Boar-fish the membrane of the first dorsal fin is not produced to form filaments, and this differentiates it from the John Dory. There are small teeth in the jaws and vomer, but none on the palatine bones.

The Boar-fish, or Cuckoo-fish, is a southern species, ranging from Madeira and the Mediterranean to our south-west coasts, where it is abundant from May to October. A bottom-living species it is frequently taken in the trawl by Brixham fishermen. It is not found in the North Sea. At the entrance to the Channel it spawns from June to August. The eggs, which have been artificially fertilised by Cunningham, are buoyant and transparent, from 0·91 to 1·01 millimetres in diameter (about $\frac{1}{25}$ of an inch). The egg contains a single oil-globule, which is often coloured yellow.

The newly hatched larva is a little over 2 millimetres long.

A Boar-fish was caught 5 miles off Gt. Ormes Head on 31st January, 1935, and sent to the National Museum of Wales at Cardiff.

ZEIDAE.

The John Dory (*Zeus faber*).

The John Dory is a fish of very peculiar shape (Plate 31). The body is high and narrow. The anterior dorsal fin consists of a few strong elongated spines; the membrane of this fin is prolonged into filaments. The second dorsal fin is rounded and not completely separated from the first. Both the second dorsal and anal fins are rounded posteriorly. Along the base of both dorsal fins on either side there is a row of spines; those at the base of the second dorsal are double, and there are similar spines along the base of the posterior anal fin. The pelvic fins are long; in fact, nearly as long as the anterior dorsal. The scales are small and spineless, the skin smooth. The colour is olive or brown with yellow bands. There is a large round black spot on each side, surrounded by a yellow ring.

The John Dory is a southern fish, its chief habitat being the Mediterranean and the Atlantic. It is common enough on the south-western and western coasts of the British Isles, where it forms an important feature of our trawlers' catches, and is by no means rare in the Irish Sea. The John Dory is much esteemed by connoisseurs, but in the writer's opinion its flesh is distinctly inferior to that of our leading Pleuronectids (flat-fish). A fish of medium depths, it is rarely taken beyond the 50-fathom line. In the North Sea it is confined to the southern area; only rare stragglers wander as far as the Norwegian coast. Almost purely a fish-eater, the Dory prefers herring, pilchards and sand eels to any other diet.

Its spawning habits have not yet been determined with

certainly. The ripe ovarial eggs have been described by Fulton; they are from 2·5 to 2·8 millimetres in diameter, which is fairly large for marine fish. Whether they are pelagic or demersal is not quite certain. They may be laid on sand in a similar fashion to the eggs of sand eels. It seems probable that the Dory spawns in the English Channel from June to August.

The Dory becomes mature in the case of the male at a length of 11 inches, in the female at 15 inches. It attains a considerable size, according to Cunningham: a length of 22½ inches and a weight of 18 lbs.

XIPHIIDÆ.

The Sword-fish (*Xiphias gladius*).

The Sword-fishes are pelagic fish of tropical and sub-tropical seas. They are easily identified by the long sword-like process of the upper jaw, and the species which occasionally wanders into British waters (*Xiphias gladius*) is further distinguished by the absence of pelvic fins (Plate 28).

Sword-fish are the largest bony fish, attaining a length of 15 feet, with a sword 3 feet long and 3 inches diameter at the base. The sword is formed by the prolongation and fusion of the maxillary and intermaxillary bones, and of course it is a very formidable weapon. Sword-fish are accused of attacking and killing whales, and it is certain they occasionally attack small wooden ships and boats, since there is in the British Museum a 2-inch plank of a whale-boat with a portion of the broken sword of a Sword-fish still in position.

Our Sword-fish is found in the Mediterranean and on the western side of the Atlantic; stragglers occasionally reach British waters, and they have even been reported as far north as Finmark. In the Mediterranean it spawns in spring and

early summer. The eggs are not known, but young Sword-fish (about 37 millimetres long) have been taken in the open Atlantic between 20° and 39° North Latitude.

It is not uncommon round the coasts of Great Britain from July to November, especially on the south and south-west, while it is not infrequently taken in the Bristol Channel and the estuary of the Severn. Day gives about eleven definite records, of which the largest was 11 feet long, taken off the Eddystone Lighthouse in June, 1879.

Since Day's time it has been captured in salmon nets at Bo'ness, Firth of Forth, in July, 1893. The sword of this specimen, which was 8 feet 2 inches long, measured 2 feet 5 inches. The stomach contained otoliths or ear-stones of young haddock and whiting, a few vertebræ, and several specimens of a Nematode.

A specimen 6 feet long was caught 200 miles east of Aberdeen in November, 1893, and another off Dunstanboro' in 1892 (Bolam).

A Sword-fish 9 feet long was also taken off Yarmouth in September, 1893 (Patterson). In August, 1903, a large Sword-fish was found on the beach at Dundreary Castle, near Inverary. The sword measured 34 inches in length.

A closely allied form *Istiophorus americanus* new to the British Fauna is described in the Appendix (p. 356).

SCIÆNIDÆ.

The Meagre (*Sciæna aquila*).

The fish of this family, the Sciænidæ, are for the most part coastal species of the tropical and sub-tropical Atlantic and Indian Oceans. Occasionally one wanders into British waters. The Meagre or Shade-fish has a rather long, compressed body covered with spiny scales (Plate 32). There are two dorsal

fins ; the first, with weak spines, is united at the base with the second dorsal, which has one spine and many rays.

The Meagre is a fish of extremely wide range, and is found at the Cape and in Southern Australia. It attains a length of 6 feet, and specimens over 5 feet long have been taken in British waters. Day gives numerous references, including one taken by trawlers in Carmarthen Bay, 5 feet long and weighing 64 lbs. In 1870 a specimen was taken in the Queen's Channel, Mersey estuary, and placed in the Liverpool Museum.

Since Day's time it has been recorded off the Irish coast in 1896 (Scharff). These large specimens taken in British waters are probably spent fish. The Meagre spawns in South African waters, where it is known as the Kabeljau. The eggs are pelagic, small, 0·82 to 0·91 millimetre, and provided with an oil-globule.

TRICHIURIDÆ.

The Hair-tail (*Trichiurus lepturus*).

The Hair-tails are a family of peculiar fish with a long, compressed, and band- or ribbon-like body. They are oceanic species of tropical and sub-tropical seas, and two of them wander occasionally into British waters. Of these the Hair-tail, or Silvery Hair-tail, or Blade-fish (Plate 33), is the commoner. The Hair-tail has a long band-like body tapering into a fine point, and it may easily be distinguished from the Scabbard-fish, which has a caudal fin. There is a single dorsal along the whole length of the back. The anal fin is rudimentary with numerous very short spines, hardly piercing the skin ; in the Scabbard-fish, while the first portion of the anal is composed of short spines, the posterior portion is composed of distinct rays. There are long fangs in the jaws. The Hair-tail attains a length of 4 feet. It has been recorded

with some regularity from our southern coasts, and is not infrequently landed by steam trawlers at our western fishing ports, but these latter have certainly been caught at some distance from our shores. Four specimens in the Irish National Museum were taken in Brandon Bay, County Kerry.

Nothing is known of its habits, growth or development.

The Scabbard-fish (*Lepidopus caudatus*).

In the Scabbard-fish or Scale-foot the body is elongated and band-like (Plate 33). A single long dorsal fin extends along the whole length of the back. The caudal is well developed and strongly forked; the pelvic fins are reduced to a pair of scales. The lower jaw is prominent, projecting beyond the upper. The jaws are provided with a single row of small compressed teeth; in addition, in the upper jaw there are two or three large-barbed fangs, and one in the lower jaw. The body is scaleless.

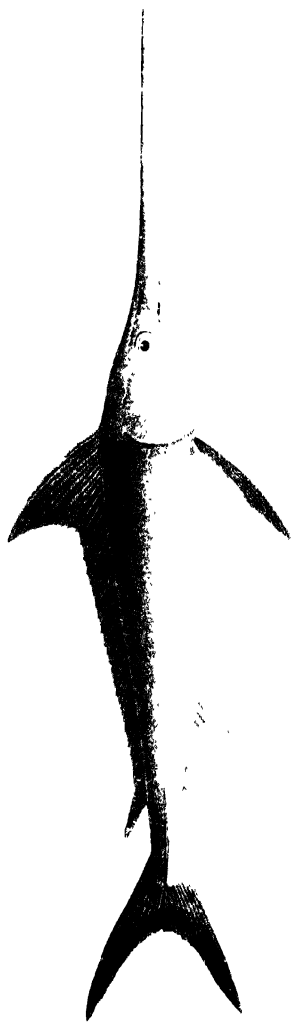
The Scabbard-fish, or Frost-fish, as it is called in New Zealand, is fairly common in the Mediterranean and eastern Atlantic. It is a fish of very wide distribution, being abundant at the Cape and New Zealand.

This species is only an occasional wanderer into British waters. There are seven records in Day from British and one from Irish waters. In January, 1896, a specimen was washed up on Cullen Sands on the Aberdeen coast (Sim).

Nothing is known of its habits and development.

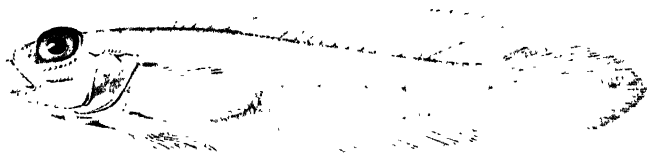
THE GOBIES (*Gobiidæ*).

The Gobies are small fish usually found on rocky coasts where they attach themselves to the rocks by their ventral fins, in this way withstanding the motion of the waves. In this family the body is scaly; there are two dorsal fins, the anterior usually with six flexible spines. The pelvic fins are united,





2



3

Pl. 29.

- | | |
|----------------------|-----------|
| 1. Rock Goby, female | } (p. 92) |
| 2. Rock Goby, male | |
| 3. Fries' Goby. | (p. 93) |

G. 87

forming a disc not attached to the belly. The gill opening is vertical and moderately wide.

The Gobies may be distinguished by the help of the following table, based on that of Holt in the Irish reports :—

A. Ventrals with anterior membrane.

1. Superior rays of pectoral separate and silk-like.

- (a) Anterior membrane of ventral separated from fin-rays and forming lateral lobes ; inter-orbital space two-thirds or more of diameter of eye ; 60 or more scales in a longitudinal series ; spinous dorsal without elongated rays or superior pale horizontal band. Giant Goby (*G. capito*).

- (b) Anterior membrane of ventrals continuous with fin rays ; inter-orbital space narrow and eyes almost touching superiorly.

- (i) Not more than 42 scales in a longitudinal series, mid rays of spinous dorsal longest.

Black Goby (*G. niger*).

- (ii) Fifty or more scales in a longitudinal series ; spinous dorsal, with a superior pale horizontal band. Rock Goby (*G. paganellus*).

2. Pectoral without separate or silk-like rays.

- (a) Conspicuous dermal papillæ on head and operculum.

Fries' Goby (*Gobius Friesii*).

- (b) No papillæ on operculum.

Inter-orbital space three-quarters of length of snout.

Conspicuous black spot at origin of caudal.

Spotted Goby (*Gobius Ruthensparri*).

Inter-orbital space less than one-half of snout. Muzzle blunt ; 34 or more scales in lateral line. Rows of black spots along dorsal fins.

Painted Goby (*Gobius pictus*).

Not more than 1 (or 2) spots at end of spinous dorsal.

Common Goby (*Gobius minutus*).

Muzzle pointed. Scales large; 25-30 only in lateral line. Jeffrey's Goby (*Gobius Jeffreysii*).

B. Anterior membrane of ventrals wanting or rudimentary.

Habit slender. Soft dorsal with black band superiorly.

No pale band on caudal peduncle. (*Gobius orca*).

Habit stout. Soft dorsal banded with red. A broad pale band on caudal peduncle.

Diminutive Goby (*Gobius Scorpioides*).

The Gobies (Genus *Gobius*).

The Gobies form a family of fish whose biological interest far exceeds their economic importance. Of small size, with the exception of one species, they rarely exceed a length of 5 inches, and for this reason alone their food value is extremely small. One of the British Gobies, *Gobius scorpioides*, is the smallest of all fish. Inhabitants for the most part of rocky pools, and of coastal and estuarine habits, there was, until comparatively recently, considerable confusion as to their classification. According to the recent researches of Holt there are ten species met with in British and Irish waters, one of which (*Gobius orca*) is represented by a solitary record.

British Gobies are short fish of stout or slender form, with more or less depressed heads, and sometimes slightly compressed bodies. A conspicuous feature of these fish is that the eyes are large, situated high up on the head and close together. Frequently they almost touch, and the inter-orbital space never exceeds the diameter of the eye. The snout is short and generally equal in length to the diameter of the eye. The scales are irregular, those at the posterior end of the body being by far the larger; those of the lateral line are not differentiated from the rest. Occasionally there are distinct lines of dermal papillæ on the head and gill covering (Fries' Goby). There are two dorsal fins, separated by a short interval; the anterior dorsal consists usually of six or seven spines. The soft dorsal

is similar to the anal; the pectoral of moderate size and rounded; the upper rays sometimes separate and silk-like.

The pelvic fins, each consisting of one spiny and five soft rays, lie together in the mid-central line. They are united to form a single fan-like fin which acts as a sucker. There is a large conspicuous urogenital papilla.

The colour is darkest on the head, the anterior part of the body, and along the lateral line, which is occasionally marked by a series of blotches and spots.

The Gobies, especially in their young stages, are difficult to distinguish apart; the analytical table (p. 87) will be of assistance, and in addition it should be remembered that, although coloration is, generally speaking, subject to great variation in fish, the form and colour of the spinous dorsal fin forms an easy method in most cases of distinguishing the Gobies apart. Absolute reliance, however, should never be placed on coloration alone; the other characters must be checked as well. Due consideration must also be given to sexual characters, as there is a great difference between the adult male and female Gobies in the breeding season, and also between mature and immature males. The colours of the male change rapidly under the influence of excitement.

All British and Irish Gobies, with the exception of the Rock Goby (*G. paganellus*), are gregarious, and this habit is not altogether lost even in the spawning season. They are all bottom-living forms, except the Spotted Goby (*G. ruthensparri*), which lives in shoals amongst weed in mid-water. Gobies may be studied in aquaria, where they are easily kept, or in rocky pools, where they live on the bottom, hiding under stones or shells, or lying flat and partly buried in sand. They are both shy and pugnacious. Their food consists of crustacea and worms.

The eggs are large, demersal, and are laid in closely set groups in an empty shell or other sheltered spot. They are

adherent to the bottom ; each individual egg is pear-shaped or fusiform and attached by its narrow base. There is a large number of small oil-globules diffused through the yolk. When hatched the larva is well developed, with the mouth already formed ; it rapidly assumes the form of the adult. In the Gobies, pairing takes place ; the site for the deposition of the eggs is selected by the male, after which he endeavours to secure the affections of a female. During this time he is extremely pugnacious, fighting with any other male who approaches him. He guards the female during the deposition of the eggs, and then protects them in the " nest," providing at the same time a current of water by the movement of his fins. After the deposition of the eggs the female disappears, taking no further interest in the proceedings. After what Holt calls " a decent interval," a week in the case of the Common Goby (*G. minutus*), the female proceeds to form an attachment for another male, while the dutiful father, after his family is safely hatched out, seeks the acquaintance of another female.

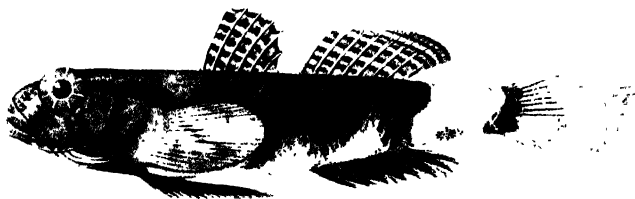
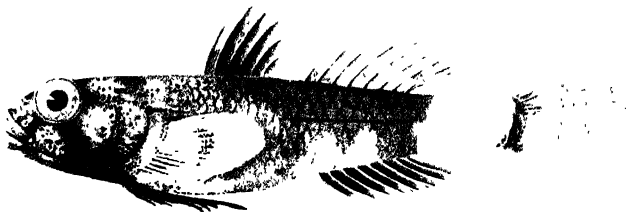
Gobies are typical of the coastal waters of the north-east Atlantic, but on account of their small size are of no account either to professional or amateur fishermen, and consequently are frequently overlooked.

The Giant Goby (*Gobius capito*).

This species was first certainly identified as a member of the British fauna by Pickard-Cambridge in Cornwall, in 1903. Numerous specimens were obtained in rock pools at Port Scath on the Cornish coast, between Falmouth and Fowey. Though probably very local in its distribution, the Giant Goby occurs in numbers, as many as twenty or thirty having been seen in the same rock pool. Though called a giant, it is really only large when considered in reference to the other species of Goby. Specimens of 7 to 9 inches long are not uncommon.



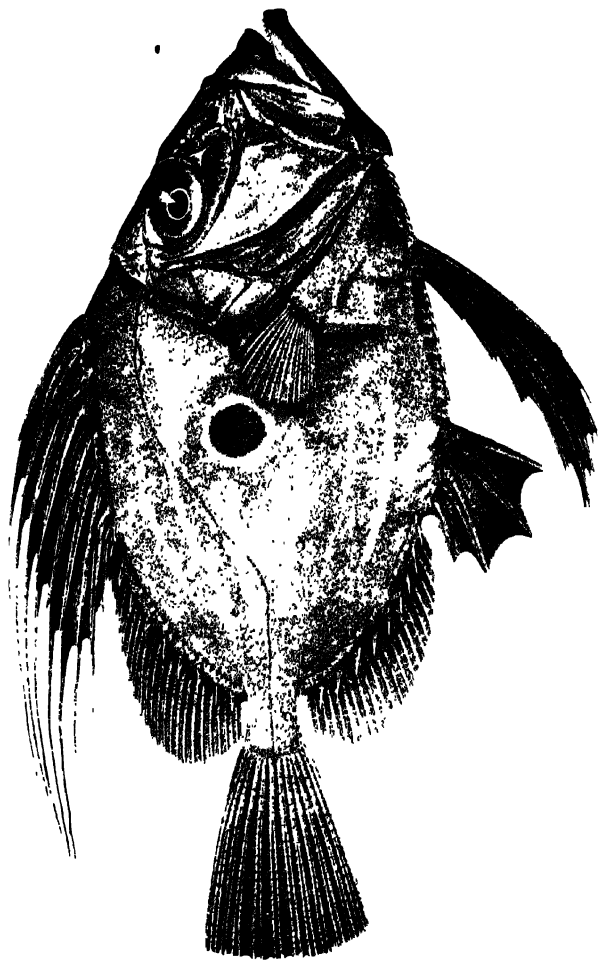
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3

P. 39.

1. Painted Goby. (p 95)
2. Diminutive Goby, female (p 96)
3. Diminutive Goby, male (p 96)



John Dory.

Smaller specimens from 4 to 5 inches might easily be confused for *G. niger*, the Black Goby, but the table given above (p. 87) will serve for the identification of the different species of this genus.

Like all other Gobies, the Giant Goby is very voracious, dashing out and seizing anything at all likely to be serviceable as food. Otherwise it is an extremely shy species, rushing off to seek shelter at the slightest alarm.

The colour varies in different individuals, ranging from pale orange-pink or sandy to sooty black. Freshly caught examples are beautifully mottled with various markings of different shades of grey).

The Giant Goby is common in the Mediterranean. In British waters it is most abundant in the Channel. The eggs resemble those of the Rock Goby (*Gobius paganellus*), but are much larger.

The Black Goby (*Gobius niger*).

The silk-like rays in the pectoral fins and the large size of the scales, together with the form of the spinous dorsal fin, which has its central rays longer than the rest with their extremities markedly depressed, serve to distinguish the Black Goby (Plate 42) from the other British species. The ground colour of the body ranges from pale ochreous-yellow through brownish or blackish-grey to smoky black, with hardly a trace of brown. The sides are not distinctly banded, the lighter and darker areas being speckled and marbled with lighter and darker markings. Growing to a length of 5 inches, the Black Goby is a frequenter of rocky or sandy ground. According to Holt it is the estuarine representative of the large British and Irish Gobies, preferring brackish water. It is abundant both on muddy and sandy ground from low-water mark to a depth of a few fathoms. The eggs are deposited

in spring wherever there is suitable shelter ; they are watched over by the male during incubation. They are fusiform in shape, about $1\frac{1}{2}$ millimetres in height, the rounded apex serving to distinguish them from the ova of the Rock Goby (*G. paganellus*), which is the only one they resemble in any way.

The Black Goby occurs all round the British coasts and is found in Norway, the Bay of Biscay, and the Mediterranean.

The Rock Goby (*Gobius paganellus*).

The Rock Goby (Plate 29) is distinguished from the other species by the band along the top of the spinous dorsal, of yellow or buff colour, or sometimes almost white. According to Holt it is not easy to express the differences in colour between the Rock Goby (*G. paganellus*) and the Black Goby (*G. niger*), except in the breeding males. The Rock Goby, however, never assumes a uniform blackish-brown or smoky-black colour, and the transverse banding or marbling is more marked than in the Black Goby, even in very dark specimens. The pale areas on the gill covers assume a rounded or oval form, while the madder markings on the dorsal fins tend to arrange themselves in the form of oblique vermicular bands.

The numerous silk-like rays in the pectoral fins, combined with the number of scales and the normal form of the ventral fins, serve to identify this species with certainty.

The Rock Goby is found all over the British coasts, in rock pools, under stones between tide-marks, and on rough ground in shallow water. It does not range to any great depth. A more southerly species than the Black Goby, it is found at Madeira, but not north of the British Isles. Spawning is in the spring ; the eggs are generally laid on the underside of a projecting rock, where they are guarded during the incubation period by the male. The eggs are fusiform, about twice as high as wide, and pointed at the apex.

Fries' Goby (*Gobius Friesii*).

This Goby is an Irish species, and was first described and added to the Irish list (under the name of *G. macrolepis*) by Scharff, from a specimen taken in 5 fathoms off the south-west of Ireland.

In colour Fries' Goby is pale grey, more or less tinged with brownish or yellowish-green. There are several well-marked rows of dermal papillæ on the head and operculum. The spinous dorsal has some of its rays produced into filaments (Plate 29). The caudal fin is large and of lanceolate shape. These features, together with the large scales (29 in a longitudinal series), the compressed form, and the absence of silk-like rays from the pectorals, serve as a ready means of distinguishing this species.

Fries' Goby appears to be not uncommon in the west and south-west of Ireland. It has been recorded in Killibeg's outer harbour; in Inver Bay, County Donegal; in Skerries Bay; and off Counties Louth and Down, where it seems to prefer a bottom of muddy sand.

Outside of Ireland there are only three records for this fish: one from Norway and two from Sweden. Its breeding habits and eggs are unknown.

The Common Goby (*Gobius minutus*).

The Common Goby is a very variable species—in fact, two distinct forms are recognised: a larger typically salt-water form attaining a length of $3\frac{1}{4}$ inches, and a smaller estuarine form reaching $2\frac{1}{4}$ inches in length. The colour is variable, but is usually sandy brown to dark grey, darker on the back, with a series of dark blotches varying in intensity and number (six or seven to twelve) along the middle line of the sides. A characteristic feature is a conspicuous black or deep blue spot

at the posterior end of the spinous dorsal fin. According to Holt the largest and brightest Common Gobies are those found off the north Cornwall estuaries, where the water is almost of normal salinity; the smallest and dingiest, on the other hand, are from the muddy and brackish estuaries of the North Sea.

Apart from the freckled body and the markings on the body and fins, the number of scales and the fin formula serve to distinguish this species from our other Gobies. The Common Goby is found almost everywhere on our coasts, and is the species most often captured in the shrimp trawls of the Lancashire estuaries. It is equally abundant in the pools of the rocky coast of Wales, and can adapt itself to living in water that is practically fresh. Essentially gregarious, the Common Goby is often seen in large numbers. Its breeding habits are those described above (p. 90) for the genus. The males are exceedingly pugnacious, and the fights between rivals in the spawning season frequently result in the death of one of the combatants. The eggs are attached to the bottom by a micropylar network. They are elongate pear-shaped. There is a succession of broods throughout the summer.

The Spotted Goby (*Gobius ruthensparri*).

The Spotted Goby is most easily recognised by the large black spot at the middle of the root of the tail. The body colour is yellowish to olive-brown, and there are a series of five or six pale saddle-like markings on the dorsal surface. The spinous dorsal fin has three horizontal bands of reddish or pink colour, the intervening portions being pale yellow or white. Similarly the second dorsal fin has three or four bands. The adult male is usually more brilliantly coloured than the female, especially in a series of short transverse markings which run across the body and are often a deep blue in the male.

This species grows to a length of $2\frac{1}{2}$ inches, and differs from

other British Gobies in that it does not rest much on the bottom but swims about in shoals among the seaweeds (such as *Laminaria* and *Zostera*) which flourish at low-water mark. The breeding habits resemble those of other gobies. The eggs, which are laid on any smooth sheltered surface, are pear-shaped with a somewhat pointed apex.

The Spotted Goby has a wide range, from Trondhjem to the Bay of Biscay. It is common in the Irish Sea, where it is known to the fishermen as the "Lady-hen."

The Painted Goby (*Gobius pictus*).

The Painted Goby closely resembles the Common Goby, and they are not always easily distinguished. In live specimens the coloration of the painted goby (Plate 30) serves as the best means of identifying the species. The fish is pale yellowish-grey, or pale brown with paler saddle-shaped dorsal markings ; on the dorsal fins are longitudinal red bands, and there is a row of black spots at the base of each. The figure, which is from Holt, is taken from a pale specimen, and the body colours are often much darker, and the black spots on the dorsal fin larger and more numerous, than there represented.

The Painted Goby prefers a coarse sandy bottom to any other. It is found between tide-marks and down to a depth of 15 fathoms. The breeding habits are very similar to those of other Gobies, the males being equally warlike. The ova are pear-shaped ; the female lays a series of egg groups during the course of the summer. The range of this species is from the Baltic to the south of the British Isles. It is not uncommon on the shores of the Irish Sea ; the specimen figured by Day was obtained from Colwyn Bay.

Jeffrey's Goby (*Gobius Jeffreysii*).

Jeffrey's Goby is described and figured by Day under the name of *Gobius quadrimaculatus*, but according to Holt the

true *Gobius quadrimaculatus* is a Mediterranean species which has not yet been found on the British coast.

Jeffrey's Goby is easy to distinguish from other British species, since the form of the pelvic fins distinguishes it from *G. orca* and *G. scorpioides*, and the number of scales distinguishes it from the Common Goby. In living specimens, the rusty brown coloration is characteristic, while there are four conspicuous dark spots along the lateral line. According to Holt the eggs and breeding habits are unknown. A deep-water form, Jeffrey's Goby lives in depths from 19 to 180 fathoms, ranging from Stavanger and the Faroe Islands to the mouth of the English Channel, where six specimens were taken off the Mewstone in March, 1897 (Holt). It grows to a length of nearly 2 inches.

Diminutive or Scorpion Goby (*Gobius Scorpioides*).

This fish is one of the smallest known, its total length being less than an inch. Consequently it is frequently overlooked, and British records of its occurrence are not numerous.

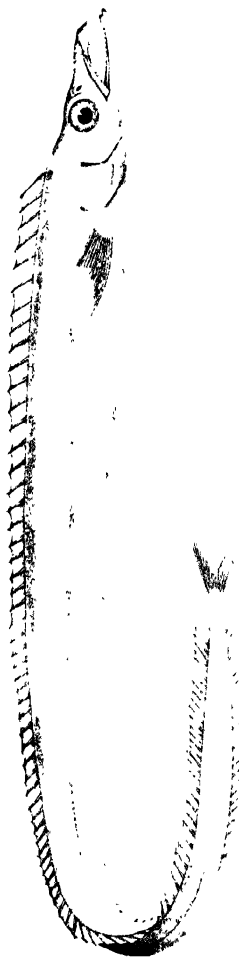
Gobius Scorpioides may be recognised by its stout body, the form of the spinous dorsal fin, the pale band on the caudal peduncle, and the form and shape of the ventrals (Plate 30). It lives in water from 2 to 74 fathoms in depth, but little or nothing is known of its habits. The eggs resemble those of other Gobies, but are smaller and spherical. Apart from Ballynakill Harbour there were until recently only five records of its capture: two from Norway, one from the Cattegat, one from British waters (Falmouth Harbour), and one from Ireland, 30 miles west-north-west of Cleggan Head. In Ballynakill Harbour it appears to be abundant, where its chief abode is the outer edge of the bar of Fahy Bay in a depth of from 1 to 3 fathoms on coarse ground. More recently, in May, 1909, it has been taken in Inishlyre Harbour, Clew Bay, by Farran; also from the Eddystone (Crawshay).



P. 32.

Meagre, p. 34.

G. 96.



1107.

Scabbard Fish
Hair-tail.

Gobius Orca.

A species of extreme rarity, only eight specimens have hitherto been recorded, one of which is British, from Kilbrennan Sound in the Hebrides. Similar to the preceding species, its body is more slender; the spinous dorsal is a uniform dull black; the soft dorsal dusky black, with a deep black upper margin separated from the rest of the fin by a row of white spots. Holt thinks that a careful search off our coasts would yield further records of this species.

The Transparent Goby (*Aphyia minuta* or *pellucida*).

The Transparent or White Goby is a small sand-loving fish, not exceeding $1\frac{1}{2}$ inches in length. Its body is long and compressed; the cleft of the mouth wide and provided with long pointed teeth. There are two dorsal fins, the first provided with five spines. The pelvics are united to form a disc not attached to the abdomen. The body is transparent, covered with large, thin and easily detached scales.

The Transparent Goby ranges from the Black Sea to the Mediterranean, and along the Atlantic coast to Norway. It is common enough on the west coast of England, and has frequently been taken in the Menai Straits and the estuary of the Dee. It is very often found in local samples of "White-bait" taken in the coastal waters of the Irish Sea. When found it is usually present in very large shoals, which are throughout their life pelagic in habit. Spawning takes place in June, July and August. According to Collett this fish lives for a year only, so that it attains its full growth in the months from October to December.

The Transparent Goby seems to be rarer on the east coast of Scotland than elsewhere, but has been recorded from the Firth of Forth (Günther), and in 1900 was seen in

Aberlady Bay, Haddingtonshire (Evans). In 1897, this species was rather abundant in the estuarine waters of Plymouth and district. Twenty were taken in the Lynher River in April, two in the Tamar in May, and a large male in *Zostera* beds in Cawsand Bay. In Ireland, Holt captured four in Killibegs Harbour in June, 1890, the largest $\frac{2}{3\frac{1}{2}}$ of an inch long.

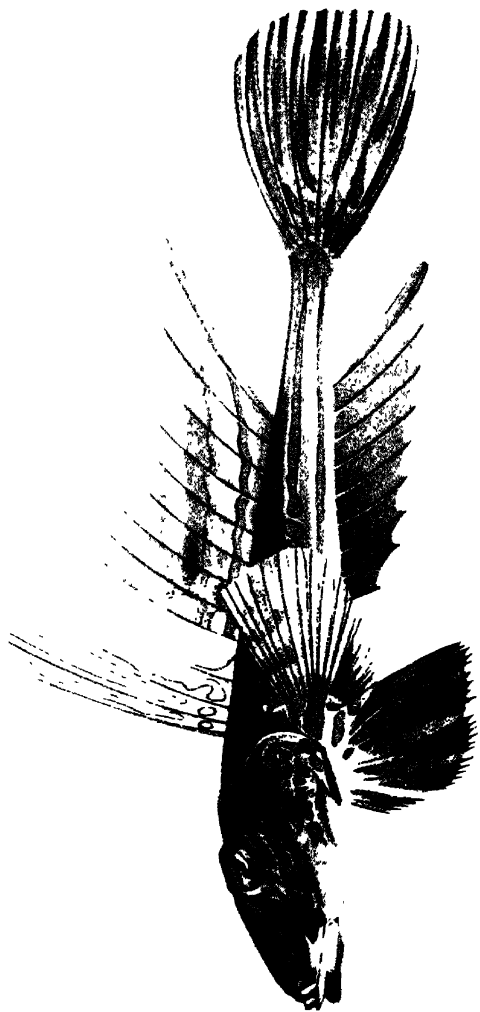
Crystallogobius Nilssoni.

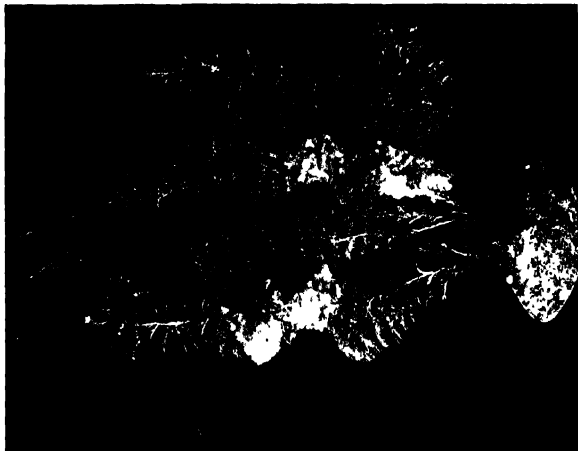
This fish is another Transparent Goby of northern waters ; it seems to be abundant off the Norwegian coast. Day gives one record, a specimen obtained by Edward in a rock pool at Banff. There is, however, little doubt that this fish is not so rare as it was formerly thought to be. No doubt, owing to its small size and transparency, and its habit of living in rather deep water, it escapes both capture and recognition. Since Day's time it has been recorded on more than one occasion in British waters, notably at Plymouth, where it is abundant. It is undoubtedly common in many localities in the North Sea.

Crystallogobius spawns in March and April. The earliest development stages are not known. According to Collett this species, like the Transparent Goby, only lives for a year. In 1890, during the cruise of the *Fingal* off the Irish coast, large numbers of this species were taken in Ballinskelligs Bay, and others were found in the stomachs of large fish in Galway Bay. It occurs abundantly along the whole west coast of Ireland in depths from 10 to 41 fathoms. It is also exceedingly abundant on the Eddystone grounds and in the deeper parts of Falmouth Bay.

THE DRAGONETS (*Callionymidæ*).

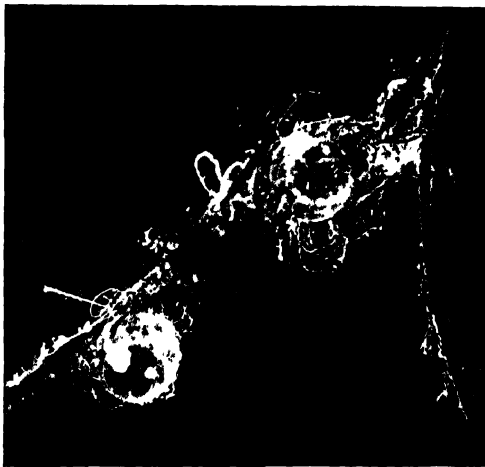
The Dragonets are handsomely coloured marine fishes of small size, of which two species are met with in British waters ;





Pl. 35

Eggs of Common Sea Snail. (p. 105)



Pl. 36

Eggs of Garfish. (p. 239)

the Dragonet (*Callionymus lyra*), and the Spotted Dragonet (*Callionymus maculatus*).

The Dragonet (Plate 34) has the head and anterior portion of the body depressed.

The body is long, slender and devoid of scales. There are two dorsal fins, the anterior with three or four flexible spines. In the male the first dorsal ray is greatly elongated, extending beyond the base of the caudal fin. The male is brilliantly coloured, and the colours are intensified in the breeding season. The sides and lower half of the head are orange, with spots and markings of blue. The upper part of the body is yellow, tinged with red, with light blue spots and markings. A dark blue band passes along the body from the base of the pectoral to the base of the caudal fin ; below this is an orange and then another blue band. The fins are also brilliantly coloured.

The female is dull brown, passing into white beneath. These secondary sexual characters are uncommon in fish producing pelagic eggs. The secondary sexual characters and the spawning habits of the Dragonet have been well described by Holt, who kept these fish successfully in confinement. The male has the power of intensifying his colours during "courtship" when he is showing himself off to the female, which he does in opposition to other males. The colour differences are so marked that it was at one time thought there were two species, the "Gemmeous" and "Sordid" Dragonets.

The Dragonet ranges from the Mediterranean to the southern coast of Norway, and is common in moderately shallow water all round the British Isles. In the Irish Sea it is among the commonest of the "inedible" fish caught in the trawl, though doubtless many individuals, on account of their small size, escape through the meshes of the net.

Spawning takes place fairly close inshore, since the eggs are frequently taken even in the estuaries on the west coast. The

season is from February to June, but may last until August. The eggs are pelagic, from 0·69 to 0·94 millimetre in diameter, and are easily recognised by the honeycombed reticulations on their capsule. There is no oil-globule. The young larva hatches out in about a fortnight. The eggs of the next species (*Callionymus maculatus*) are very similar, but may be distinguished by their smaller size (0·66 to 0·79 millimetre), and the closer surface reticulations. In both species the larvæ and young fish lead a pelagic life during their first summer, seeking the bottom during the winter.

The Spotted Dragonet (Plate 36) was at one time thought to be extremely rare in British waters. Day gives only one record, "dredged off the Shetland Isles, and placed in the British Museum." Since the species are much alike and are of no economic importance, it is probable that the existence of the Spotted Dragonet has been repeatedly overlooked. The most characteristic difference is in the markings of the second dorsal fin, which in the Spotted Dragonet has three or four rows of black ocellated spots, but in the Common Dragonet is indistinctly blotched or banded.

Since Day's time there are a number of records of the Spotted Dragonet: from the Hebrides, Firth of Clyde (Gunther); from Fair Isle, October, 1900 (Fulton); and from the west coast of Ireland (Holt), who also was the first to record it in English waters at Falmouth in 1897. In the Irish Sea it was first recorded in 1902, in Liverpool Bay, on the Deposit Grounds by the steamer *Beta*. While the Spotted Dragonet is certainly rarer than the common form, there is no doubt that a careful search would show it to be fairly common, even though from its smaller size it may be less often caught in the trawl.

Its breeding habits are similar to those of the Common Dragonet. The eggs and larvæ have been described by Holt.





Eggs of long spined Sea Scorpion. (p. 19)



Pl. 37.

Eggs of Lumpsucker. (p.

Pl. 101.

THE SUCKERS (Discoboli).

This family of marine fish is distinguished by a rounded body, transversely expanded or oblong. Skin naked or provided with tubercles. The teeth are small. The ventral fins consist of one spine and five rudimentary rays, which form the framework of a round suctorial disc with a cutaneous outer margin. The gill openings are narrow.

The British forms are three in number, one belonging to the genus *Cyclopterus*, and two to the genus *Liparis*. These may be distinguished :

Body thick, short, lumpy, with a viscous tubercular skin.

Head large ; snout short. *Cyclopterus*.

One species (*C. lumpus*).

Body sub-cylindrical, in a more or less loose naked skin.

Head broad, obtuse. *Liparis*.

The two species of *Liparis* may be distinguished :

Body with irregular horizontal dark bands : most distinct on the anterior portion of the body.

Sea Snail (*Liparis vulgaris*).

Body with numerous small dark spots. Diminutive Lump Sucker or Montagu's Sucker (*L. montagui*).

The Lump-sucker (*Cyclopterus lumpus*).

Along the Lancashire coast the Lump Sucker (*Cyclopterus lumpus*) is invariably termed by fishermen the "sea-hen," and the name *Iar-for*, given to the species in the neighbouring Welsh counties, has the same meaning. It attains a length of 2 feet, though the specimens usually met with are much smaller (Plates 39, 41). In the early months of the year, at low spring tides, numbers of these fish are left stranded by the receding waters, particularly on the sandy shores of Morecambe

Bay, each adult male mounting guard over a mass of eggs (Plate 37). From this peculiarity the fishermen's name of "Hen-fish" is derived, while the term Lump-sucker refers to the adhesive disc on the ventral surface of the body. As Pennant states in his "British Zoology," "By means of this part it adheres with vast force to anything it pleases. As a proof of its tenacity, we have known that on flinging a fish of this species just caught into a pail of water, it fixed itself so firmly to the bottom that on taking the fish by the tail the whole pail was by that means lifted, though it held some gallons, and that without removing the fish from its hold." In the British Isles there is no regular fishery for the Lump-sucker, but it is frequently taken by stake-nets and by the inshore trawlers. The Hen-fish is remarkable as one of the very few marine species which exhibits any solicitude for its young, and it is invariably the male which keeps watch over the eggs and by the constant movement of its pectoral fins maintains a flow of water through the mass of spawn. This current of water serves for aerating the eggs, and prevents those in the interior of the mass from being suffocated.

The male differs from the female in both size and coloration ; he is smaller and, especially in the breeding season, of a brick-red colour on the ventral surface, whereas the female is yellowish-white. According to Dr. Fulton, the mature female lays from 79,000 to 136,000 eggs. The breeding season is during the spring months of the year, and apparently the whole of the eggs are laid together, but not in a solid mass, since there are holes and cavities which allow the access of water to the interior. Professor McIntosh has given a graphic account of the paternal care exhibited by this fish. As a rule the eggs are laid on the shore between half-ebb and low-water marks, so that for a portion of each tide they are uncovered. While so exposed they are preyed upon by numerous enemies, such as rooks, starlings, seagulls, and rats. When covered by the tide they

are the prey of various fishes ; codling, for instance, devour them eagerly.

It will be seen that the male fish has no sinecure when he is engaged in guarding the eggs, and that he does his duty well Professor McIntosh bears eloquent testimony : " While on guard the males are frequently attacked by rooks and carrion crows, which thrust their sharp beaks through the abdominal wall, and feast on the liver of the unfortunate fishes, which thus yield their lives to the faithful discharge of their duty." In one particular instance a Lump-sucker was kept under observation for several weeks, and during the whole of the time it remained faithful to its charge, even though for a considerable period twice daily it was partly exposed at ebb-tide. When removed a couple of yards from the eggs and placed on a stone it wriggled actively into the water and at once rushed to the eggs, assuming its former position with its snout almost touching them. The same thing happened when it was removed to a greater distance. On one occasion a heavy storm caused masses of eggs to be swept from their positions far up the beach, and as soon as the sea became calm, numerous Lump-suckers could be seen seeking for their charges.

The feeding and physiology of digestion in the Lump-sucker are matters that need further research. The creature's stomach is generally widely distended with water, so that when perforated the water spurts violently out and the stomach walls collapse. According to recent researches of Dr. Apstein, it is only in the winter months that food is found in the stomach of this fish, and it consists principally of crustacea. From April to November practically no food is taken. The first part of this period is covered by the breeding season, but it is certainly surprising that no attempt is made by the fish to obtain sustenance after the spawning season is over. According to one theory it is very lazy, and instead of hunting

its prey like most other fish it sits attached by its sucker to the sea bottom, and waits patiently for something to turn up. In winter its food is abundant, in summer scarce ; hence the absence of food in the alimentary canal during the latter period. A number of observers have recorded the presence in the stomach of the Lump-sucker of a whitish mass of the consistency of curdled milk or soft cheese (composed of an immense number of infusoria), the function of which is extremely doubtful. Whether they are parasites or whether they play some physiological rôle in the digestive activities of the fish is uncertain ; but probably the latter view is correct.

The stomach of the dyspeptic Lump-sucker is also the home of a fungoid growth which clothes the whole of the mucous membrane of the stomach walls, and, in addition, a giant bacillus is frequently present. The fact that these organisms can exist in the stomach of the Lump-sucker is due to the enormous volume of water it always contains. Otherwise they would be destroyed by the action of the digestive fluids, which here are much too diluted.

The " Hen-fish " is not much eaten in the British Isles, being both flabby and insipid. It is, however, frequently met with in continental markets, and probably, as better fish get scarcer, it will, like the Angler-fish, find its way regularly into our own inland markets. At present it does not appear in the official British fishery statistics, though in Denmark, where it is included in the returns, its value (for 1907) was nearly £7,000. Only the male is used for food, as his flesh is far firmer than that of the female. The foreign fisherman goes along the shore armed with a stick with a strong hook at the end, and captures the unfortunate male while he is guarding the eggs. Smoked " Hen-fish " is considered a delicacy in Holstein. It can hardly be considered so when fresh, since a large specimen may be purchased for a couple of groschen.

The Common Sea Snail (*Cyclogaster liparis* or
Liparis vulgaris).

The Sea Snails are small fish of the northern temperate region, extending beyond the arctic circle. There are several species, of which two, the Common Sea Snail (*C. liparis*) and Montagu's Sea Snail (*C. montagui*), are found in British waters. In these fish the body is sub-cylindrical, enveloped in a more or less loose, naked skin. The head is broad and obtuse. There is one dorsal fin with feeble flexible rays. Small villiform teeth on the jaws, none on the palate.

The Common Sea Snail is a north Atlantic species (Plate 38). In America it extends south to Connecticut, and on the east side of the Atlantic to the Channel. It is more common in the north than in the south of Britain, and extends along the coasts of Norway to Spitzbergen and Kara Sea. In the Baltic it reaches to the Gulf of Bothnia. The spawning period commences in January, the eggs being laid in masses which are found adherent to seaweeds or zoophytes. In the figure (Plate 35) several masses of eggs are shown adherent to *Sertularia argentea*. The egg masses are found in depths from low-water to 30 fathoms. Those of the Common Sucker or Sea Snails are clear, and so may be distinguished from those of Montagu's Sucker, which are usually coloured. In both cases an oil-globule is present. The larvæ of the Common Sea Snail are 5·4 millimetres long and are pelagic. These species both appear to be seasonal migrants, appearing between tide-marks in summer, when they are occasionally caught in shrimp trawls. They retire to deeper water in winter.

Montagu's Sea Snail (*L. montagui*).

This species resembles the former very closely, both in structure and habits (Plate 38). The eggs are laid in masses,

and they adhere to algæ and seaweeds. The illustration (Plate 53) shows eggs of Montagu's Sea Snail adherent to the seaweed *Plocamium coccineum*. These eggs were formerly mistaken for those of the herring, which, however, though demersal are not laid in masses. According to McIntosh, at St. Andrew's, they are almost the only eggs obtained by the local fishermen in February, March and April, attached to zoophytes and seaweeds. These egg masses are mostly laid here in comparatively shallow water from 4 to 6 fathoms in depth. They are also found offshore in from 15 to 30 fathoms. During the trawling expeditions, specimens were sometimes sent in as herring eggs, from which, however, they are distinguished, even when separate, by the structure of the capsule and yolk. The spawning period is from January to July. The eggs are smaller than those of the Short-spined Cottus or the Herring. They are hardy and will survive exposure on the deck of a fishing-boat for some hours. The larvæ have frequently been hatched out at St. Andrew's, even from eggs after a long journey in damp seaweed. Montagu's Sucker is common from the north of Norway to the Channel.

THE SUCKERS (Gobiesocidæ).

The Suckers or Cling-fish are small shore fish of tropical waters. On account of their small size they are of no economic importance. As their name indicates, they are provided with an adhesive apparatus, which, however, only resembles superficially that found in the Sea Snails or Sea Suckers (*Liparis* and *Cyclopterus*).

The suckers in British waters are represented by four species of the genus *Lepadogaster*. In this genus the sucker or suctorial disc is formed of the widely separated pelvic fins (which constitute a portion of the margin of the sucker) and cartilaginous or gristly prolongations to a certain bone of the

shoulder girdle, the coracoid. In *Cyclogaster* and *Liparis* the fins form the centre and base of the disc. In *Lepadogaster* the disc is relatively large, the length being about one-third of the whole length of the fish.

The British species may be thus distinguished :

Dorsal fin continuous with the caudal.

More than 10 rays in the dorsal fin.

Cornish Sucker (*Lepadogaster gouanii*).

Dorsal fin distinct from caudal.

More than 10 rays in the dorsal fin.

Connemara Sucker (*Lepadogaster decandolii*).

Less than 8 rays in the dorsal fin.

Caudal with 12 rays.

Two-spotted Sucker (*Lepadogaster bimaculatus*).

Caudal with 17 to 19 rays.

Small-headed Sucker (*Lepadogaster microcephalus*).

All these suckers (Plate 40) have pretty much the same distribution, ranging from the Mediterranean northwards to the British Isles. They are found on our coasts, under stones between tide levels in pools. The Two-spotted Sucker is the smallest, attaining a length of 2 inches only; the Cornish Sucker, which is the largest, grows to 4 inches in length. The Small-headed Sucker, which was described by Brook as a separate species in 1890, is by some authorities considered to be merely a variety of the Two-spotted Sucker, but on the whole it appears to be specifically distinct.

All the suckers lay demersal eggs, usually in June or July, in empty shells. The eggs, which are elongated, are attached to the bottom by the flattened long side. The larva hatches out in about four weeks. In winter, the young fish migrate into deeper water, and this migration, offshore in winter and inshore in summer, appears to be characteristic of these fish, which are supposed to become adult in their third year.

THE BLENNIES (Blennidæ).

The Blennies are coastal fish of small size and great variety, inhabiting all temperate and tropical seas. Some of them are found in brackish water. In this family one of the chief distinguishing features is the pelvic fin, which is formed of less than five rays and is jugular in position. In some blennies the pelvic fins are functionless, becoming rudimentary; or they may be entirely absent. The form of the body is elongate, low and cylindrical. One, two or three dorsal fins are present, occupying nearly the whole length of the back.

The various British members of the blennies may be distinguished by the following characters. There are six genera, only one of which, *Blennius*, is subdivided into species, so far as British representatives are concerned:—

Molar teeth present. The Cat-fish (*Anarrhichas lupus*).
No molar teeth.

A distinct caudal fin.

Spinous and soft portions of dorsal fin nearly equal.

Orbital tentacle present.

First dorsal fin not elevated.

Fourteen rays in pectoral fin.

Gattorugine (*Blennius gattorugine*).

Pectoral with 12 rays, black band at base.

Montagu's Blenny (*Blennius galerita*).

First dorsal fin elevated.

Butterfly Blenny (*Blennius ocellaris*).

Orbital tentacle absent. The Shanny (*Blennius pholis*).

Dorsal fin of spines only.

Pelvic fins distinctly jugular, gill membranes slightly united at the throat.

Lumpenus (*Lumpenus lampetraeformis*).

Pelvic fins of several rays, distinctly jugular.

Yarrell's Blenny (*Chirolophis galerita* or *Carelophus ascanii*).

Pelvic fins very small, consisting of 1 spine and 1 ray.

The Gunnel (*Centronotus gunnellus*) (*Pholis gunnellus*)

No caudal fin. Viviparous Blenny (*Zoarces viviparus*).

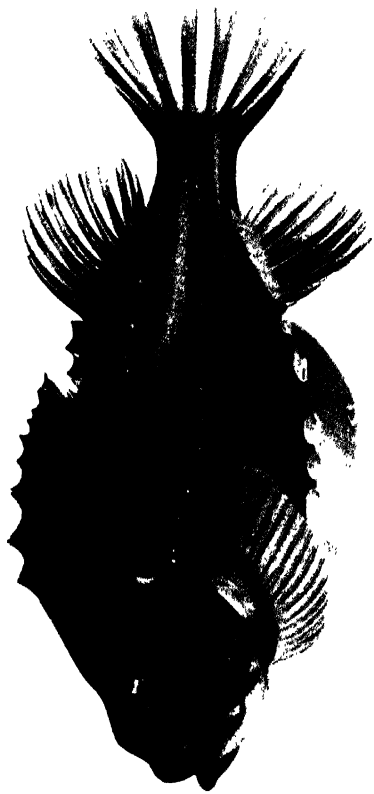


Fig. 1



Fig. 2

Common Sea Snail. (p. 100)
Montagu's Sea Snail. (p. 105)



The Cat-fish (*Anarrhichas lupus*).

The Cat-fishes are species of northern and Arctic regions, frequenting deep waters, being rarely taken in depths of less than 30 fathoms. Of the three northern species, the Common Cat-fish (Plate 42), *Anarrhichas lupus*, is the only one at all numerous in British waters. The Smaller Cat-fish (*A. minor*), which is common enough off Iceland, wanders into our waters occasionally. A third species (*A. latifrons*) was taken 15 miles off the Tyne in 1906 and 1910 and in November 1926. Also in April, 1928, east of Outer Skerries, length 42 inches, weight 46 lbs.

The Cat-fish is sometimes included with the Blennies, but more recently it has been placed in a distinct family (the *Anarrhichadidae*). The Sea-cat, Cat-fish, or Wolf-fish is distinguished from the Blennies by its large size, with the tail fin small and separate. There are no pelvic fins, and the scales are rudimentary. The teeth are remarkable: there is in the front part of each jaw a group of long curved canines, and in the posterior part of the lower jaw a double row of rounded molars. The roof of the mouth is provided with three double rows, the middle ones flat, those of the sides pointed.

In colour it is blue-grey, with a series of black bands passing from the back a little more than halfway down the sides. It ranges from the west coast of France to the Arctic regions; in the northern part of the North Sea it is abundant. It is found on the American side of the Atlantic down to Cape Hatteras. There is only one certain record for the Irish Sea.

A winter spawner, from December to January, its eggs are laid in ball-like masses (Plate 43) on the bottom. Each egg is about a quarter of an inch in diameter, and the Cat-fish therefore has the largest eggs amongst marine bony fish.

The eggs are yellowish and opaque. McIntosh received a mass of live eggs in January, 1886, at St. Andrew's, and was successful in hatching out the larvæ. The young larvæ are transparent and slender, with a very large yolk-sac. Some of these larvæ, which were hatched at the end of January, were kept alive at St. Andrew's until the middle of May, by which time the yolk was all absorbed. The Cat-fish differs from most marine fish of economic importance in the length of larval development before the yolk is absorbed. In most marine fish the absorption of the yolk only takes a week or so, whereas in the Cat-fish it lasts for about three and a half months, by which time the larva has attained the character of the adult fish. Whether the male protects the eggs, as in the closely allied blennies, is not known.

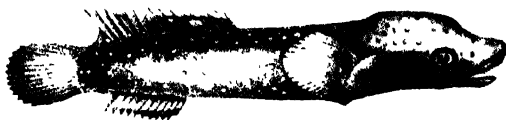
The Smaller Cat-fish referred to above (*Anærrhichas minor*, Olafsen) is distinguished from the Common Cat-fish by the absence of cross bands of dark colour across the body. Instead of these dark bands, the body, head and fins of the Smaller Cat-fish are covered with many large round black spots. This species extends to both sides of the Atlantic, being recorded from the coast of Maine and Norway. In 1891, a female 42 inches long and weighing 26 lbs. was caught in a trawl-net off Aberdeen and sent to the Glasgow market, where it was purchased and presented to the Paisley Museum. So far as the writer can ascertain, this is the first record for the British fauna.

Gattorugine (*Blennius gattorugine*).

The Tompot or Gattorugine (Plate 44), the largest of our Blennies, is not uncommon in British waters; at any rate, on our south-west coast and in the Channel, where it reaches its farthest north. It is common in the Mediterranean. This species is distinguished by the well-developed fringed orbital tentacle, by the first dorsal fin being not elevated, and by the number of rays (18) in the anal fin. A deep-water species,



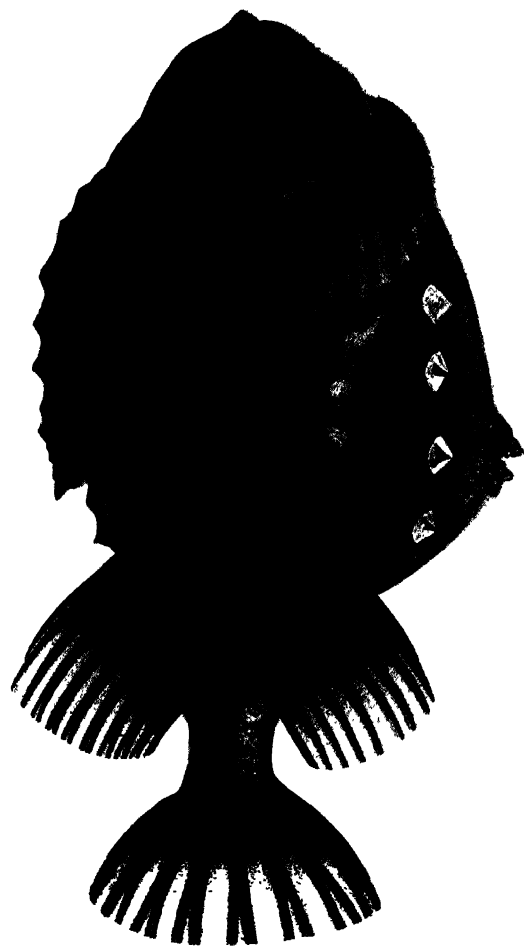
Cornish Sucker.



Connemara Sucker



Double-spotted Sucker.



it is sometimes taken in crab-pots off the Cornish coast. Its eggs and earlier larval stages are unknown.

Montagu's Blenny (*Blennius gallerita*).

Montagu's Blenny (Plate 45) is found in the north-east Atlantic from the British Isles to the Canaries, as well as in the Mediterranean and Black Sea. It may be most easily recognised by the absence of the orbital tentacle and the numerous bluish-white spots which cover the whole of the head, body and fins (except the anal). There are also large milk-white blotches on the body. A coastal species, it lays demersal eggs in August under stones between tide-marks. The eggs are deposited close together and have a felt-like appearance. The male has been observed to mount guard over the eggs in the same manner as the Shanny. The young are pelagic during the summer, probably seeking the ground in the following winter.

The Butterfly Blenny (*Blennius ocellaris*).

The Butterfly Blenny (Plate 44) is a handsome little fish, easily recognised by its orbital tentacle and by the elevated first dorsal fin bearing a large black ocellated spot. This species is found from the Mediterranean to the British Isles, and is not uncommon in summer and autumn off our south-west coasts. It does not often appear farther north, and there are only two records of its capture in the trawl, on the Lancashire fisheries steamer in the Irish Sea: the first 15 miles west by north of Morecambe Bay Lightship in May, 1894, and again in Cardigan Bay in August, 1912. Probably it is commoner than would appear, since it prefers rocky grounds where there is abundant seaweed, and so is not often taken in the trawl. The eggs and young have been described by Cunningham, who found the eggs of this species on the sides of a cavity of a large hollow bone, probably an ox thigh-bone, at Plymouth. The eggs are of orange-red colour, demersal, and of 1·20 millimetres

diameter. The Butterfly Blenny attains a length of 7 inches. Its flesh is very soft and not much esteemed.

Yarrell's Blenny (*Chirolophis galerita*).

Yarrell's Blenny (Plates 45, 49) possesses two pairs of orbital tentacles, but it may be distinguished from the other ble because its dorsal fin is long and undivided; the pectorals small, and there are small scales present on the body. This species is a distinctly northern fish, being found from the north of Norway to our south and south-west coasts. Spawning takes place in October and November, the demersal eggs being deposited in shallow water. The young larvæ are usually caught in surface tow-nets in December and January.

Yarrell's Blenny attains a length of $7\frac{1}{2}$ inches and is probably not rare in British waters, but, since it is a fish of no economic importance, is perhaps overlooked, except by specialists in fish-life.

A specimen 7·3 inches long, weighing 43·5 grammes, was taken off North Berwick at a depth of 10 fathoms, in 1894, by hook and line baited with mussel. Since then there are two records for the Yorkshire coast: one from Scalby Ness in November, 1897, the other at Filey Brigg in March, 1920 (W. J. Clarke).

A specimen from 4 to 5 inches long was taken at the west end of Portobello beach in the Firth of Forth in November, 1901 (Evans).

The Shanny (*Blennius pholis*).

The body of the Shanny (Plate 45) is coloured greenish-olive or yellow, and either banded or blotchy, covered with dark spots. The fins are yellowish, and also covered with black spots like the body. The anal fin has a black, white-margined outer edge. There are no scales, hence this species is sometimes called the Smooth Blenny.

The Shanny is the commonest of the British blennies, and is to be found in rock pools between the tide marks all round the British coasts. It is said to leave the water and bask on the rocks in the sunshine !

The Shanny ranges from the North Atlantic to the western part of the Mediterranean.

It spawns in June, laying a collection of eggs side by side and close together under a stone, or in crevices or cavities in the rocks near low-water mark. The eggs are bright amber in colour and about $\frac{1}{16}$ of an inch in size. Saville Kent described the breeding habits from observations of fish kept in the Manchester aquarium. A pair of fish selected a narrow ledge high up on one side of the tank for a nursery. The eggs were deposited in a single layer on the ledge, first by one and then by a second female ; so this species is polygamous. "The male had meanwhile undergone a wonderful colour transformation. All the gay mottlings of yellow and brown that usually characterise the species had given way to a uniform tint of deep sooty black, the large prominent lips alone remaining nearly white ; his appearance under such circumstances being particularly ferocious and forbidding." The male now mounts guard over the eggs, keeping off enemies until the young fish are safely hatched out.

Lumpenus (*Lumpenus lampetrisformis*).

Another rare blenny which is found occasionally off the British coasts is *Lumpenus* (Plate 49). A northern genus, it is represented by a single species, *Lumpenus lampetrisformis*, in our waters.

The body is elongate, covered with minute scales. The lateral line is more or less distinct, and sometimes there are several lateral lines. The dorsal fin is long and formed of spines only ; the pelvics with two or three rays. The first record in our waters is by McIntosh, who obtained a specimen

from the east coast of Scotland in May, 1884. This species ranges from the Arctic down to the North Sea and Western Baltic, and on the American side of the Atlantic to Cape Cod. The eggs are probably demersal, but have not yet been found. Spawning takes place at Christmas-time, and the young larvae have been found in February and March in the North Sea and Baltic. It seems to be well established and widely distributed in the Firth of Forth (1895), and in 1900 it was not uncommon there. In May, 1884, a specimen was taken 16 miles off St. Abb's Head, and one in April, 1885, in the Moray Firth, since when many hundreds have been taken from the same locality (Sim). Meek records it off the Northumberland coast (1903 and 1907). Irish records Co. Down (1905) and Co. Louth (1906).

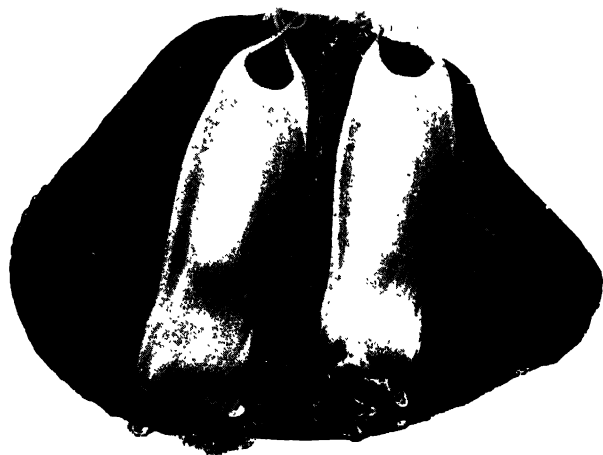
The Gunnel (*Pholis gunnellus*).

The Gunnel, or Butter-fish (Plate 49), one of the blennies, is distinguished by its elongate body, which is covered with very small scales. There is no lateral line. The snout is short, and there are very short teeth in the jaws. There is a row of black spots, with a white ring around each, along the base of the dorsal fin. The dorsal fin is long and formed of spines only. The tail fin is not separate from the dorsal. The gill openings are of moderate width, and the gill membranes coalescent.

The Butter-fish is a northern species extending to both sides of the Atlantic, down to Wood's Hole on the west side and to the Channel on the east. The eggs, which measure 2 millimetres in length, are deposited in small masses, usually in cavities in the rocks or in empty shells. These masses are about the size of a brazil nut, and the parent fish are coiled round the eggs. The habit has also been observed when the eggs were laid in the aquarium of the laboratory at St. Andrew's. The female, in laying the eggs, rolls them up into a ball by curving the body into a loop, in which the eggs are laid. The male



Cat Fish. (p. 100).
Black Goby. (p. 91)



Pl. 43.

Eggs of Catfish. (p. 109).

Eggs of Dogfish. (p. 318).

L 115.

By permission of Messrs. Edward Arnold & Co

also takes his share in guarding the eggs during the period of incubation. The spawning season lasts from December to March. In the illustration (Plate 48) the male Gunnel-fish is seen protecting its eggs, which have been deposited in an empty oyster-shell. "The object is evidently to prevent the ova, which are adhesive only when first extruded, from being scattered and lost." Care of the eggs is very rare among fish, and for it to be taken by both parents is still rarer. As a rule the function is taken over by the male parent, as in the Lump-sucker, Sea Horses and Sticklebacks. The egg has a diameter of 1·17 millimetres, with a colourless yolk and a single oil-globule. The protective membrane is so fragile that it is impossible to detach one egg from the rest without rupturing it. The hatching period lasts considerably more than a month. The larvæ at hatching measure about 9 millimetres. They may be distinguished from the larvæ of other blennies by the length of the intestine. The larvæ are pelagic in habit for several months, and during that period drift out to sea. They have been taken in Scotland off the Isle of May, in mid-water at 30 fathoms. The Gunnel, therefore, is a coastal species with a demersal egg, the young of which pass through a pelagic existence in offshore waters before they return to their coastal habitat.

The Viviparous Blenny (*Zoarces viviparus*).

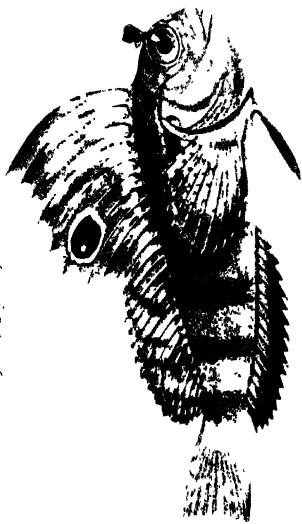
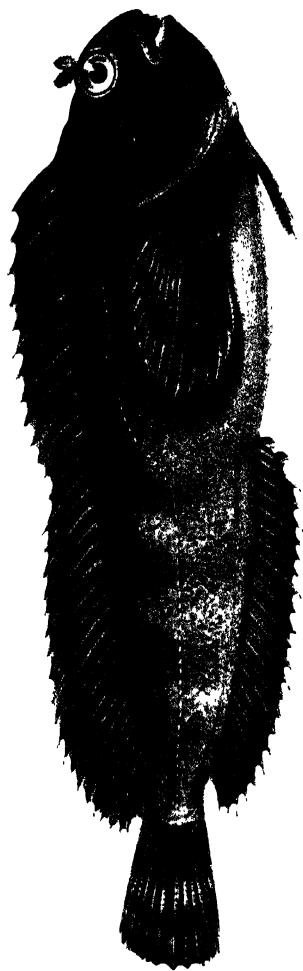
The Viviparous Blenny, or Eel-pout, has a body tapering towards the end of the tail, with rudimentary scales, and conical teeth in the jaws (Plate 46). There is a single, low, long, dorsal fin, with a depression on the tail which is formed by a series of spines much shorter than the rays. The tail fin is not separate. The ventral is short, formed of three or four rays. The gill openings are wide.

The Viviparous Blenny is a coastal species widely distributed over Northern Europe. It extends from the White Sea and

the Baltic to the Bay of Biscay, and is a common shore fish of the British Isles. It has long been studied by naturalists since Schoenevelde first described it in 1624.

It is peculiar in that it has a single roe or ovary lying along the mid-line of the body ; in this peculiarity it resembles the Gunnel or Butter-fish. Most fish, of course, have two roes ; one on each side of the abdominal cavity. The eggs, instead of being ripened and shed externally, are developed in cavities, are fertilised in the ovary and hatched there, the young being retained in the capacious ovarian chamber until they have attained a considerable size. This viviparous habit, which is rare in fishes, is found in widely separated families, and how it has originated it is difficult to say. Adults examined in November, December and January are characterised by a great distension of the abdomen, due to the enlarged ovary. In fish which are viviparous, it is obvious that the eggs must be fertilised within the body of the mother, and the males of these species are usually provided with an intromittent organ. In the Viviparous Blenny this is merely an elongated papilla on which the testicular canals open. The eggs develop in follicles which are situated on processes or papillæ. Like the eggs of non-viviparous species, those of *Zoarces* are contained in a spherical egg-membrane, in which the embryo develops for a time until the egg-shell is burst and the embryo set free in the ovarian chamber.

Hatching takes place about twenty days after fertilisation. The embryos are observed to lie over each other in a solid mass, but the surrounding fluid in the ovarian chamber not only moistens their gill membranes but enables them to slip over each other with ease. The young are not born until about four months after fertilisation ; that is, more than three months after they have escaped from the eggs. The newly born young are about $1\frac{1}{2}$ inches long, and in every external feature exactly like the parent. Since the yolk is not large



I 116.

Gattorugine. (p 110),
Butterfly Blenny. (p 111)

Pl. 44.



in amount, it follows that the young are nourished by the albuminous liquid which is formed in the interior of the ovary as a secretion from its walls. The number of young produced varies greatly. Young females from 7 to 8 inches long produce from twenty to forty young, while the largest females produce 300 or more young at a birth. The intra-ovarian development of other viviparous fishes differs considerably from that of the Viviparous Blenny. There is considerable variation in the amount of nourishment derived by the young from the yolk-sac and the ovarian secretion respectively. In some cases the nourishment is chiefly derived from the yolk, as in the *Cyprinodonts*, and this is considered to be the primitive condition. In other cases, as in certain Indian rays, the amount of nourishment derived from the ovarian secretion is considerable, and in one case projections, or villi, are actually observed passing into the spiracles of the embryo, and through these villi the uterine "milk" is poured into the throat of the foetus.

CEPOLIDÆ.

The Red Band-fish (*Cepola rubescens*).

The Band-fish family consists of small marine fish of more or less demersal habits, found in the tropical eastern Atlantic, Mediterranean, Indian and Pacific Oceans.

The Red Band-fish, or Red Snake-fish—so named on account of its appearance—has a low, compressed and much elongated body covered with very small cycloid scales (Plate 46). The eyes are large and lateral in position; the teeth of moderate size. There are very long dorsal and anal fins, consisting of soft rays, and both are continuous with the caudal. The pelvic fins are thoracic in position, consisting of one spine and five rays. The gill opening is wide. The body is coloured red, splashed with yellow; the dorsal fin is yellowish, tinged with red, and the pectorals deep rose-red in colour.

The Red Band-fish visits British coasts occasionally, but must be considered rather a rare fish, since Day gives only about fourteen separate records. It has been recorded by Holt, in December, 1897, two specimens, $12\frac{1}{2}$ inches and $10\frac{1}{2}$ inches long respectively, being taken in Plymouth Sound. The Glasgow Museum has a specimen captured off the Irish coast in April, 1928 (Absalom). Other Irish records off Mine Head, Co. Waterford, August, 1906.

Very little is known of its spawning habits. The egg is supposed to be pelagic, but has only been obtained from the stomach of a ray, on the west coast of Ireland. It is not met with to the north of the British Isles.

TRACHYPTERIDÆ.

The Vaagmar or Deal-fish (*Trachypterus arcticus*).

The family of the Trachypteridæ is represented in British waters by two species, the Vaagmar and the Oar-fish, both of which are deep-sea fish, not infrequently washed up on our shores or captured by our fishermen. Both are fish of remarkable appearance, the body being long and band-like. In a specimen from 15 to 20 feet long the depth of the body will be less than a foot. The British species are easily distinguished, since a caudal fin is present in the Vaagmar and absent in the Oar-fish.

These fish are deep-sea forms, and evidently representative of an abyssal group. When they reach the surface, the diminution of the pressure of the water on the body tissues gives rise to an expansion of gases which so destroys the flesh that when lifted out of the water the fish often breaks to pieces.

The Vaagmar (Plate 47) is distinguished by the very long

body, with a dorsal fin extending practically along the whole length of the back, consisting of simple unbranched rays. The pectoral fins are very short, of five rays, situated close to the head. The specimen figured by Day shows no pelvic fins, but according to Gunther the pelvics are well developed, being composed of several more or less branched rays. There is no anal fin.

The Vaagmar, or Deal-fish, is a resident of the deep water, 200 to 300 fathoms and above, of the Northern Atlantic. Specimens are occasionally washed ashore in Norway, Sweden, Denmark, and in the northern parts of the British Isles—particularly in the Shetlands.

The pelagic egg and young stages of closely allied species have been described, but the eggs and young larvæ of the Vaagmar have not yet been identified with certainty. The young of the closely allied Mediterranean species (*Trachipterus iris*) are remarkable for the greatly elongated anterior dorsal and pelvic fin rays. Day gives about a dozen well-authenticated records of the appearance of this fish on our shores, the largest specimen, however, being only $7\frac{1}{2}$ feet long. Since Day, it has been reported fairly frequently: at Berwick in 1891 (Bolam), by Traquair in June, 1896, at Lunasting in the Shetlands—a sadly battered specimen with the caudal fin missing, its length without the fin being 6 feet 7 inches. Cursiter says upwards of a dozen specimens were recorded from the Orkneys, but none between 1851 and 1896, when in April one was stranded at Stembister, 6 feet 2 inches long, depth exclusive of the dorsal fin $14\frac{1}{2}$ inches, thickness $3\frac{1}{2}$ inches. There was a black spot on each side of the anterior dorsal region. In August, 1888, one was found on the beach at Mennie, Aberdeenshire, by salmon fishermen; it measured 4 feet long and was 9 inches broad. There are other records at Banff in 1905 (Lemon), at East Lothian in 1909 (Evans), and by Cole in 1913.

Banks' Oar-fish or Ribbon-fish (*Regalecus banksii*
or *Regalecus glesne*).

The second British representative of the Trachypteridæ is the Oar-fish, whose long body has also a very curious and characteristic appearance.

The Oar-fish (Plate 47) is remarkable for the production of the pelvic fin into a long filament dilated at the end, while the caudal is absent. The dorsal fin commences in the forehead between the eyes, the first ten to twelve rays are produced in the females. The body is of the colour of tinfoil, with few irregular dark spots and streaks situated on the anterior part.

The name Oar-fish is derived from the presence of the two pelvic fins, which are dilated at the extremity something like the blade of an oar. This fish is also called the "King of the Herrings," from the mistaken idea that it accompanies the herring on its migration to our shores. It is the largest of all ribbon-fish, frequently exceeding 20 feet in length. Possibly the undulations of the body of this fish, when swimming at the surface, are responsible for some of the stories of "Sea-serpents."

It has been captured at the Faroes, Norway, Scotland, and the north coast of England. In British waters it must be regarded as a rare visitor, as according to Gunther there are only sixteen British captures between 1759 and 1878, the largest of which was said to be 18 feet long. Since 1879 there are several additional records. In February, 1884, a specimen 17 feet long was taken in a stake-net by salmon fishermen at Fraserburgh, and in April, 1884, another was taken at Buckie; another, 12 feet long, was washed into Sandhaven harbour in January, 1891; and still another specimen, 16 feet 3 inches long, was taken in the estuary of the Findhorn and sent to the British Museum in May, 1896 (Sim). This last

specimen, weighed $1\frac{1}{2}$ cwts. Another specimen was captured on the coast of East Lothian in 1908 (Evans). It has been recorded at Amble in 1876. The pelagic eggs, larvae, and young stages have been obtained in the Straits of Messina.

THE SAND SMELTS (*Atherinidæ*).

The Sand Smelts resemble the Grey Mullets. The body is rather elongate, sub-cylindrical, and covered with scales of moderate size. The lateral line is indistinct. The cleft of the mouth is of moderate or large size. The gill openings are wide. The pelvic fins are somewhat behind the pectoral. There are two dorsal fins, both short.

The Sand Smelts of British waters are sometimes mistaken for true smelts (*Salmonidæ*), but the Sand Smelts have a bright silvery band down the side, and have no adipose fin. The family is characteristic of tropical and temperate seas. There are a number of genera, one only of which (*Atherina*) is represented in British waters by two species : *Atherina presbyter* and *Atherina boyeri* (Plate 51).

The Sand Smelts are small coastal fish, rarely exceeding 6 inches in length. The Common Sand Smelt (*A. presbyter*) is found in the Mediterranean, the Channel and the North Sea as far north as the Firth of Forth. Meek records it at the mouth of the Tyne in December, 1909. The eggs, which are demersal, measure nearly 2 millimetres and are provided with delicate filaments which serve for attachment. At the entrance to the Channel the spawning season is in June and July, the young appearing inshore in Cornwall in June. The newly-hatched larvæ are very transparent. The young fish leave the coast in the autumn, returning again in spring.

The occurrence of the second species, *Atherina boyeri*, in British waters must be regarded as doubtful. The only record

is by Couch, and since the specimens are lost the identification cannot be verified. This species has never been recorded elsewhere in northern waters.

THE GREY MULLET (Mugilidæ).

The members of this family are very similar in appearance. The body is elegantly shaped, rather elongate and compressed, and covered with smooth scales. There is no lateral line. There are two short dorsal fins, the anterior consisting of four spines. The ventral fin is opposite the second dorsal. The pelvic is behind the pectoral. The tail fin is large and somewhat forked. The mouth is narrow or of moderate width, and the teeth, if present, are feeble. The Grey Mulletts are southern species and frequent coastal waters, entering the brackish waters of harbours and estuaries. They not infrequently enter docks. Off the west coast of England they appear in early summer, leaving again in autumn. They move in shoals, and occasionally are captured in enormous numbers in seine-nets. They are, however, somewhat difficult to capture, as they escape by leaping over the net, and when one leads the way the others follow. They feed on the green and brown seaweeds found in shallow water, and also suck in sand and stones on which a greenish growth is present. After working this around in the pharynx it is ejected. Each branchial arch is provided on either side, on its whole length, with gill rakers, forming a sieve for the passage of water, the other substances being retained in the cavity of the pharynx. The stomach is divided into two portions, the second portion resembling the gizzard of birds, being provided with an exceedingly strong muscular coating. This muscle is not divided into two, as in birds, but is of great thickness in the whole circumference of the stomach. The intestine is very long and much folded. In a mullet 13 inches long, the length of the intestine is 7 feet.

There are about one hundred species of grey mullets, most of which are found in tropical seas and rivers. There are three British grey mullets :

The Thick-lipped Grey Mullet (*Mugil chelo*).

The Thin-lipped Grey Mullet (*Mugil capito*).

The Golden Mullet (*Mugil auratus*).

The egg of the Thin-lipped Grey Mullet has been described by Raffaele. It is a pelagic egg measuring 1 millimetre in diameter, and provided with a large oil-globule. The species is, however, so often met with in brackish water that it is probable it occasionally spawns there, and possibly the egg, though typically pelagic in structure, may become demersal and undergo its development on the bottom. They have, at any rate, not hitherto been recorded in plankton catches. The Grey Mullet may be partly anadromous; at any rate, the South African mullets have this habit. The spawning season is in spring and summer. The larvæ are very small, being only 2 millimetres in length. They appear to remain inshore until they have reached a length of an inch or more. In the case of the Thick-lipped Grey Mullet (Plate 50), the young, in the Plymouth aquarium, attained a length of from 2½ to 3 inches in their second summer.

There are a large number of species of mullets in the genus *Mugil*, Gunther's Catalogue giving sixty-six. Of these, *M. capito* and *M. auratus* are described as British, whereas *M. chelo*, Cuv., is not so recorded. The third British species mentioned by Gunther is *Mugil septentrionalis*, Gthr., of which he says: "This species is closely allied to *M. chelo*, with which it has hitherto been confounded, but it may be readily distinguished by its shorter pectoral fin, its thinner upper lip, the different form of the præ-orbital, and its longer tail." According to Patterson, a specimen of *Mugil septentrionalis* was obtained at Breydon, near Yarmouth, in November,

1890, and identified by Gunther. Collett and Steindachner, however, say this is the same species as *Mugil chelo*, Cuv.

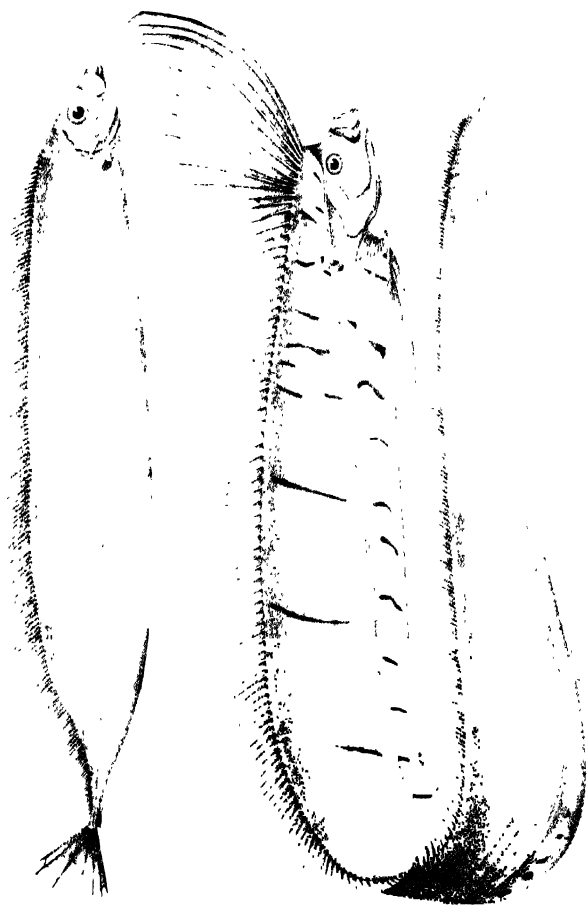
THE STICKLEBACKS (Gasterosteidæ).

The Sticklebacks are fish of the cold and temperate regions of the northern hemisphere. Of the three British species two, the three-spined and the ten-spined, live in fresh water; the third, the fifteen-spined species, in salt or brackish water. The Sticklebacks are well known and easily identified fish, so that a detailed description of their appearance is unnecessary (see Plate 7).

Three-spined Stickleback (*Gasterosteus aculeatus*).

The Three-spined Stickleback (Plate 7) (*Gasterosteus aculeatus*), which is common everywhere in the British Isles, is a small, but active, pugnacious fish usually found in fresh water, but equally at home in brackish water or in the sea, where, however, it is rare, so far as the writer's experience goes. On one occasion only has it been caught in a shrimp trawl, in the Lancashire Fisheries cutter in the Mersey estuary, in really salt water. This species is subject to great variation, no less than six varieties being described by Day. There are numerous local names for this fish, such as Jack Sharp, Prickleback, Sharpling, Barstickle or Bandie. The Three-spined Stickleback is widely distributed, being found in Greenland, Iceland, Siberia, Japan and Alaska. Spawning takes place in the early summer, in May and June. Both males and females assume a deeper coloration at this time. The Sticklebacks are among the few nest builders found in fishes. The three-spined species makes a nest of weed, the fronds of which are bound together by gelatinous threads produced by a secretion of the kidneys, which at this time become swollen and





Deal Fish. 1180
Ribbon Fish. 1181

changed in function. The female deposits the eggs in a hole in the nest, the male mounting guard over them and forcing a current of water over them by moving his pectoral fins, until the young are strong enough to leave the nest. During this time the male parent repels any intruder who may approach the nest too nearly. The young larvæ are hatched out in from eight to ten days, though this time may be extended if the temperature of the water is lower than usual. In the autumn the fish retire to deeper waters. According to Pennant, every seven or eight years enormous shoals of this fish appeared in the Welland, moving up the river in a vast column. A man, employed by a local farmer to catch them, is said to have gained for a considerable time four shillings a day by selling them at a halfpenny a bushel.

Ten-spined Stickleback (*Gasterosteus pungitius*).

The Ten-spined Stickleback (Plate 7) (*Gasterosteus pungitius*) has much the same distribution as the preceding species, although it appears to be absent from a great part of Europe. In Great Britain it is not found north of Durham on the east; on the west it ranges to Loch Lomond, and is rare in Ireland. As in the Common Stickleback, the male builds a nest of water-weeds from May to July, in shallow water near the banks of ponds or streams. After the nest is built the male seeks out a female, who deposits her small yellow eggs in the nest. This fish is said to be polygamous, more than one female laying her eggs in the same nest. The nest is built and the eggs deposited in about twenty-four hours. The young fish are hatched out in about a fortnight.

Fifteen-spined Stickleback (*Gasterosteus spinachia*).

The Fifteen-spined Stickleback (Plate 36) (*Gasterosteus spinachia*) is a salt-water species, occurring all around our

coasts and also from the Baltic to Finland ; in the North Sea, to the North Cape and the Faroes. The spawning habits of this fish are well known. The male, at the approach of the spawning season, changes colour to blue, while the female retains her ordinary green colour. The male constructs a nest (Plate 53) from a suitable branch of seaweed, usually on the margin of a rocky pool in a sheltered locality, binding together the fronds of the seaweed by a thread-like secretion from the kidneys. The threads are passed through and around the weed-fronds, which are gradually pushed into a pear-shaped or ovoid structure about the size of a man's fist. A cavity is formed in the nest by the movements of the snout and body of the fish. The male next secures a mate, who deposits her eggs in the nest, the male mounting guard during the period of incubation, which lasts usually from three to four weeks. The eggs are amber-coloured and twice the size of the preceding species, measuring 2 millimetres in diameter. The fifteen-spined species is more solitary in its habits than the other sticklebacks, and records for the west coast are by no means common ; possibly the fish is frequently overlooked on account of its small size. Nevertheless it is the largest of our sticklebacks, attaining a length of 7 inches ; the ten-spined species rarely exceeds from 2 to $2\frac{1}{2}$ inches, and the three-spined $3\frac{1}{2}$ inches.

CENTRISCIDÆ.

The Trumpet-fish (*Centriscus scolopax*).

This fish, which is called the Trumpet-fish, Bellows-fish, Woodcock or Snipe-fish, is the only British representative of the family *Centriscidæ*, a group of small, feeble marine and pelagic fish, abundant in the tropics but only rarely wandering into temperate regions.



Male Butterflyfish guarding Eggs. (p. 115)



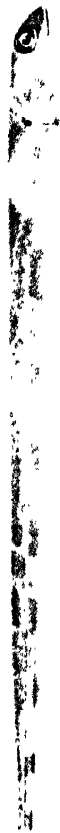
1" 18

Short spined Sea Scorpion guarding Eggs. (p. 48)

120.



1



2



3

The Trumpet-fish is of very peculiar appearance, the body being elongate, elevated, and compressed, covered with small rough scales. The snout is prolonged into a tube, terminating anteriorly in a small mouth with no teeth. There are bony strips on the side of the back, on the thorax and abdomen. The abdomen is sharp and compressed, with a few spines along its lower margin. The first dorsal fin is very peculiar, the second spine being very long and strong, equalling half the total length of the body. The pelvic fins are small, abdominal in position, consisting of five rays only. The colour is rosy splashed with gold, sometimes olive to dark along the back. Sides and abdomen silvery.

The Trumpet-fish has a very wide range, from Tasmania and India to the North Atlantic. A feeble swimmer, it has occasionally been carried by the Gulf Stream or Florida Current into British waters. There are very few authentic records in Day's book. In 1906 it was recorded in Ireland (Patterson).

THE WRASSES (Labridæ).

In this family the body is oblong or elongate. There are teeth in the jaws, but none on the palate. There is one long dorsal fin, the spiny portion of which is as much or more developed than the soft part. The anal fin rays are similar to those of the dorsal fin. The pelvic fins are thoracic in position, that is, almost directly underneath the pectoral fins. Most of the Wrasses are easily recognised by their thick lips which are sometimes folded internally.

Seven species of Wrasses are met with in British waters, and these are referred to six genera. The distinguishing characters are :

Dorsal fin many rayed (more than 20), 13 of which, at least, are spinous.

Anal spines 3.

Teeth in a single series.

Scales in lateral line above 40.

Scales with blue or white centre. Fins spotted.

The Ballan Wrasse (*Labrus maculatus*).

Scales uniform. No large spots on fins.

Cuckoo Wrasse (*Labrus mixtus*).

Scales in lateral line below 40.

The Gilt Head (*Crenilabrus melops*).

Teeth in the jaws in a band, outer series of stronger conical teeth.

Gold-sinny (*Ctenolabrus rupprestris*).

Anal spines more than 3.

Teeth in the jaws forming a band.

Scale-rayed Wrasse (*Acantholabrus palloni*).

Teeth in a single series.

Rock Cook (*Centrolabrus exoletus*).

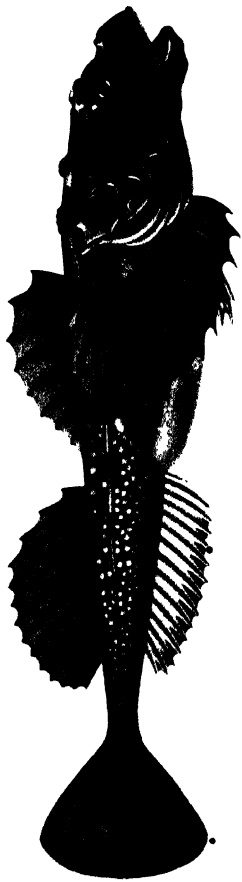
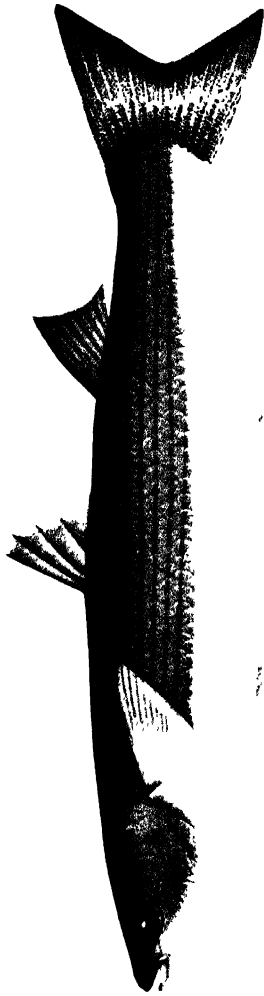
Less than 13 spines in the dorsal fin.

Rainbow Wrasse (*Coris julis*).

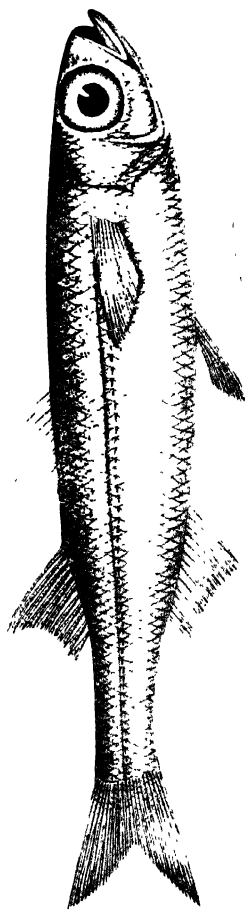
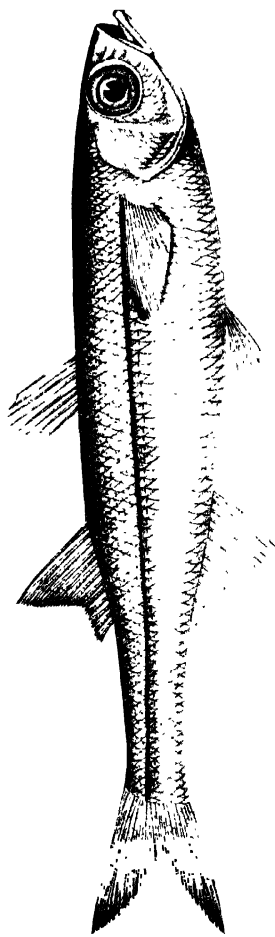
The Wrasses.

Although there are seven Wrasses met with in British waters, they are not fish of any economic importance. Sea anglers frequently take them, especially off rocky coasts. Their flesh is little esteemed. Our Wrasses may be easily recognised by their thick lips and brilliant coloration, the body being beautifully coloured, not only with permanent pigment but also with vanishing iridescent reflections on the scales (Plate 52).*

Of British forms the commonest in the writer's experience is the Ballan Wrasse (*Labrus maculatus*, or *Labrus bergylla*), which ranges from Scandinavia to the Mediterranean, and is frequently taken by rod and line in the Isle of Man, since it prefers moderately deep water and a rocky coast. The Ballan Wrasse varies a lot in its coloration (Plate 52). Generally



Lesser Grey Mullet.
 Four-horned Sea Scorpion.



The Sand Smelt. 1911
Bover's Sand Smelt. 1912

the back and sides are blue or green, each scale on head and body having a bluish or whitish spot. The vertical fins are covered with orange or yellow rings. This species spawns from May to July, and it is one of the few marine fish which makes a nest. These nests have been described by Matthews as consisting of masses of seaweeds wedged into rocks between tide-levels. The eggs, which measure from 1·01 to 1·14 millimetres in diameter, are loosely adherent to the seaweed.

The young fish lead a planktonic existence during the first summer.

The scales of the adult have clearly marked annual rings of growth, and the determination of age by observations on the scales has been very successful in this fish. It readily takes a bait, but its flesh is poor and not to be compared with members of the cod and plaice family.

Another common British species is the Striped or Red or Cuckoo Wrasse (*Labrus mixtus*), which is found from the Mediterranean to the west coast of Norway, and, as it readily takes a bait, is frequently caught by sea anglers. Again we have great colour variation, and a difference in colours between the adult male and female, as in the Dragonet. The male (Plate 52) is yellow or orange tinged with red, with five or six blue bands radiating backwards from the eye. Fins yellow or orange, with a large blue blotch on the anterior part of the membrane of the dorsal fin. In the female the blue body bands are absent, and there are two or three large black blotches on the back beneath and behind the soft dorsal fin. The Cuckoo Wrasse spawns from May to August, and, like the Ballan Wrasse, deposits its eggs in nests. It is rather rare in Scottish seas, but a specimen 12 inches long and weighing 15 ozs. was taken on a long line in 20 fathoms, on rocky ground 1½ miles from Lybster, in November, 1901 (Lillie).

The Corkwing, or Sea Partridge (*Labrus melops*, or *Crenilabrus melops*), ranges from the Mediterranean to the southern

North Sea and the Baltic, and is one of our commonest wrasses. It is distinguished from the preceding species by its serrated pre-operculum and its distinctive coloration (Plate 52). There are a number (about eight) of vertical dark brown bands on the body extending down from the back to the abdomen. There are usually one or two dark longitudinal bands on the spinous dorsal; on the soft dorsal and caudal, ocellated spots, and on the soft anal dark round spots are present. The Corkwing builds nests usually from the common seaweed (*Fucus*), in which are deposited a large number of eggs, which are not adherent but lie loose in the nest. A gregarious species, the Corkwing lives in shallower water than the other wrasses, and may frequently be taken in rock pools.

The Gold-sinny Wrasse (*Ctenolabrus* or *Labrus ruprestris*) has the teeth in the jaws in a band, imbricate scales on the cheeks and opercles, and more than three anal spines. Like the preceding species, it ranges from the Mediterranean to the Baltic. The colour is pink or golden, darker on the back. The fins are reddish, the dorsal having a black blotch on its anterior portion. Spawning takes place from May to August, the female producing free swimming pelagic eggs from 0·72 to 0·94 millimetre in diameter, devoid of an oil-globule. The period of incubation is the shortest amongst pelagic eggs, and at a temperature of 60° F. lasts only two days. A small species, the Gold-sinny seems to be rare in the Irish Sea, but a specimen was obtained in the trawl on the Lancashire Fisheries cutter in the Rock Channel, Mersey estuary, in February, 1907.

The Scale-rayed Wrasse (*Acantholabrus palloni*) is a very rare visitor to British waters. Day gives only two records for this species, which is really a Mediterranean and southern Atlantic form, though it has been recorded as far north as Norway. It probably visits our coasts oftener than the records indicate, since it is a deep-water fish and may escape capture.

In this species, the teeth in the jaws are in a band, there are imbricate scales on the cheeks and opercles, and the anal spines are more than three in number. Like the other wrasses it is brilliantly coloured, being deep orange-violet or blue on the back, becoming reddish on the sides. There is a large black oval blotch between the last three or four spines on the dorsal fin, and another on the dorsal surface at the base of the caudal fin. Nothing is known of its habits or development.

The Rock Cook (*Centrolabrus* or *Labrus exoletus*) is a small fish not exceeding 4 or 5 inches in length. The Small-mouthed Wrasse, as this species is sometimes called, is only occasionally taken in the British Isles. It is distinguished by the teeth being in a single row instead of in a band. The colour is rich brown along the back, yellow on the sides, and silvery below. Nothing is known of its habits and development.

The last British Wrasse for consideration—the Rainbow Wrasse (Plate 52), *Coris julis*—is a small species, of very brilliant coloration, attaining a length of 7 inches or thereabouts. In the male, a broad yellowish-white indented band runs along the upper surface of the body; in the female, a light yellow band passes from the eye to the base of the caudal fin. The eggs are pelagic, small, from 0·60 to 0·67 millimetre in diameter, with a yellow oil-globule. Day gives only two records of its appearance in British waters, but since then other specimens have been recorded, including one from the Isle of Man, at Port St. Mary, in 1896.

GADIDÆ—COD FAMILY.

Fish with soft fin rays devoid of spines. Scales small and smooth. The dorsal and ventral fins together, extend

along the greater part of the length of the fish. Caudal fin separate. Pelvic fins on throat in front of pectorals. Eyes large. In many species, barbels on lips or chin.

The family may be divided into four groups :

- I. Species with three dorsal fins and two anal. Body not much elongated.
- II. Two dorsal fins, the front one short, the posterior long ; one anal fin.
- III. Two dorsals, the anterior narrow and sunk in a groove in the back.
- IV. One long dorsal and one long anal fin.

The first group contains the ten British species of the genus *Gadus*.

These species may be distinguished by the following characteristics :—

Barbel present.	Upper jaw larger. Green-yellow in colour : numerous small dark spots ; lateral line white. <div style="text-align: right;"><i>Cod (G. morrhua).</i></div>
	Upper jaw larger. Absence of small spots ; black blotch on shoulder ; lateral line black. <div style="text-align: right;"><i>Haddock (G. aeglefinus).</i></div>
	Upper jaw larger. Very deep in body ; copper coloured with broad upright dark bands. <div style="text-align: right;"><i>Bib (G. luscus).</i></div>
	Upper jaw larger. Similar but not so deep. Brownish-yellow ; no bands. <div style="text-align: right;"><i>Poor Cod (G. minutus).</i></div>
	Lower jaw larger than upper. Colour dark. Teeth in upper jaw equal in size. Skin very dark, almost black on back. <div style="text-align: right;"><i>Coal-fish (G. virens).</i></div>
	Lower jaw larger than upper. Teeth in outer series in upper jaw stronger than the others. <div style="text-align: right;"><i>Norway Pout (G. esmarckii).</i></div>



1. Rainbow Wrasse. 2 Cuckoo Wrasse. 3. Ballan Wrasse. 4. Corkwing.

Urophycis regia (Cuv.) *Urophycis regia* (Cuv.)



Pl. 53

Nest of fifteen-spined Stickleback. (x 100)



Pl. 133

Eggs of Montagu's Sucker or Sea Snail. (x 100)

No barbel.	{	Sides, silvery. A black spot at root of pectoral fin.
		Whiting (<i>G. merlangus</i>).
		Dull green. Lower jaw longer than upper.
		Pollack (<i>G. pollachius</i>).
		Body narrow, silvery. Outer row of teeth in both jaws enlarged. Second dorsal fin short. Lower jaw slightly longer than upper. Poutassou (<i>G. poutassou</i>).
		Body moderately elongated. First anal rather longer than the other fins. Silvery Cod (<i>G. argenteus</i>).

The second group contains five different genera, each of which is represented in British waters by one species. These genera may be distinguished by the following features :—

First dorsal fin well developed	{	Live	Body elongate. Scales minute; fins narrow.
		in	Ling (<i>Molva vulgaris</i>).
		salt	Scales larger and fins broader.
		water	Hake (<i>Merluccius vulgaris</i>).
			Pelvic fin forms a long bifid ray.
			Fork Beard (<i>Phycis blennoides</i>).
			Fresh-water species (very small scales).
			Burbot (<i>Lota vulgaris</i>).

First dorsal fin rudimentary. Head flattened and fleshy.

Lesser Fork Beard (*Raniceps raninus*).

The third group contains three British species of Rocklings included in the genus *Motella*. They are distinguished by :

Two barbels on upper lip, one on chin.

Three-bearded Rockling (*M. tricirrata*).

Three barbels on upper lip, one on chin.

Four-bearded Rockling (*M. macrophthalmia* or *cimbria*).

Four barbels on upper lip, one on chin.

Five-bearded Rockling (*M. mustela*).

The fourth group contains one British species, in which there is one long dorsal fin and one long ventral :

The Torsk or Tusk (*Brosmius brosme*).

The Cod (*Gadus morrhua*).

The Cod (Plate 55) is coloured olive-green or brown, with dark marbled spots, the under side silvery. The snout projects over the mouth. The lower jaw has a long barbel. The lateral line has a shallow curve over the pectoral fin.

The Cod is one of the most important of our sea fish ; it has been the object of a regular fishery from early times. While the Herring is the most important of our pelagic fish, the Cod is the leading demersal species, and in fact comes second only to the Herring in importance in the statistical returns for North European seas, being the second most valuable economic fish in the world.

It is now caught mainly by trawl and long lines, though our inshore fishermen occasionally catch it with hand lines and stake-nets set on the shore. Consumed fresh, it is one of the most delicious of our sea fish, whether fried as cod steaks or boiled and served with some suitable sauce, such as shrimp or oyster sauce. In northern lands, Iceland, the Faroes and Newfoundland, it is gutted, split open and salted or sun-dried, and exported in enormous quantities to Spain and Portugal and the Mediterranean countries generally.

According to Ehrenbaum, between 300 and 400 million Cod are yearly captured by the fishermen of various countries in North Atlantic waters, of a value estimated at £5,000,000. About 200,000 fishermen take part annually in the cod fisheries ; the preparation of the fish for the markets and the various shore industries connected therewith give employment to a large number of other people. At the present time the chief Cod fishing grounds are the Newfoundland Banks, the Icelandic waters, off the Lofoten Isles and in the North Sea. The Cod extends into the Pacific, and there is a wide area in the Gulf of Alaska and off the Aleutian Islands where probably some day a very extensive fishery will be carried on. The great fishery

on the Newfoundland Bank is carried on by American, British and French fishermen, and in the past has been productive of serious disputes which, in some cases, have played an important part in bringing about wars between these nations. Recently these fishery disputes between the American and British fleets have been happily settled by arbitration at the International Court at the Hague. The fishery on the Newfoundland Bank has been vividly described by Kipling in his novel, "Captains Courageous."

It is one of our oldest sea fisheries, and already at the end of the sixteenth century was participated in by Basque, French, Spanish and English fishermen. The French fishery has always been important, and is recognised by the Government as a splendid training ground for sailors, and has therefore been, and still is, subsidised by a system of bounties which bear a high proportion (about 23 per cent.) of the total value of the fishery.

Another important cod fishery is that off Iceland, formerly, like the Newfoundland fishery, carried on by long and hand lines, now participated in by British and Continental steam trawlers. The French fishery has been described accurately, and in a moving and appealing manner in Pierre Loti's great novel, "An Iceland Fisherman."

Apart from the cod landed in Iceland itself, the greater part caught in these waters and landed in Europe (including Great Britain) is caught by British trawlers, who took before the war very nearly twice as much as all other nationalities put together. In the waters off the Faroe Islands the British also got the lion's share, namely 87 per cent. There is also an enormous Norwegian fishery off the Lofoten Islands in the winter and spring months (January to April). In weight, but not in value, this far exceeds all other fisheries put together.

The bulk of the cod caught in the northern fisheries is split open, washed, and salted in pickle and then dried on rocks

(Klippen). This is the so-called Klipp-fish. Part of the catch is dried without being previously salted (Stock-fish). The roe is salted and exported to France, where it is used as bait in the sardine fisheries. The livers are utilised in the preparation of cod-liver oil.

In the value of cod landed the British Isles come first easily, though the weight of the Norwegian product exceeds the British. Our fishermen still rely to a great extent on the North Sea, where cod represented in 1933 28 per cent. of the total demersal fish captured, though there are, naturally, fluctuations from year to year. In the North Sea the weight of cod caught by fishermen of all nations is only exceeded by the haddock; in value, the cod comes third, haddock and plaice being first and second. The bulk is caught by trawlers, but there is even yet a considerable long-line fishery in the North Sea for cod, participated in by Scottish, Dutch and French fishermen. In the case of the Dutch and French, the cod is for the most part salted on board. This long-line fishery is carried on at the Dogger Bank. The lion's share of the North Sea cod is claimed by British fishermen, who are responsible for about 70 per cent. of the total. The Norwegians, who come second, only get about 27 per cent.

Of recent years the Ministry of Agriculture and Fisheries has collected statistics of the North Sea fisheries in a careful and scientific manner. In addition to the total weights and values landed at each port, records of individual voyages of all first-class fishing vessels, both sail and steam, are kept. Notes are made of the sizes of the fish, their trade classification into "small," "medium," "large," and so on, with the areas and the depth of water of the locality of capture.

The result is that we have valuable detailed information of the distribution of cod of various sizes, at different periods of the year, in various depths in the North Sea. It is impossible to quote these details here; reference should be made to the

various official reports by those who desire further information.

Very few cod are caught in water less than 10 fathoms in depth, the bulk coming from fishing grounds lying between the 10 and 40 fathoms line. The statistics of the Scottish Fishery Board, which apply to vessels landing fish in Scottish ports, are also very carefully collected and thoroughly classified and analysed prior to publication. Their method of collection differed from the English Central Authority in that the division of the North Sea was not made according to the depth of water, but areas of equal size were taken. In 1920, the English Central Authority adopted a system of rectangles of 1° longitude and $30'$ latitude. The market statistics at Aberdeen have been very thoroughly examined by D'Arcy Thompson, to whose papers on the distribution of Cod and other demersal fish reference should be made. All this statistical information has an important bearing on the vexed question of over-fishing. Can man so deplete the stock of fish in any given area as to render a recovery improbable, or render commercial fishing impossible in the future for any given species in a particular area? The captures of our fishermen have been reduced to weight caught per hundred hours' fishing, and the analyses also show the quantities caught in each month in the year. To the question as to over-fishing no definite answer can be given at present. The areas fished over are so extensive, the statistics to be studied are so enormous, the fluctuation so great, the period over which they have been collected is so small, and also has been so interrupted by the disturbance caused to fishing by the operations of the war, that we cannot say definitely that the Cod shows unmistakable signs of depletion. We do know, however, that some of our valuable demersal species, such as the plaice, show sure signs of over-fishing; in other cases the evidence collected shows us that the money and time spent on the collection and analysis of the statistics

has not been wasted, and a strong case has been made out for its continuance on an even more elaborate and extended scale.

Cod are caught in greatest numbers in the first three months of the year, the best month being March. Cod congregate together in the early months of the year on suitable grounds for spawning purposes, and it is precisely at this time they are caught in greatest numbers by our steam trawlers. In the North Sea the Cod spawns from January to March, and the coincidence between this spawning time and the period when the maximum catches are made shows this clearly.

As will have been gathered from the above brief description of the fishing grounds, the Cod is a widely distributed species of the North Atlantic, occurring chiefly between 50 and 75 degrees North Latitude in depths from 10 to 100 fathoms. A mature female cod produces from three to over seven million eggs, according to its size, and of the young fish hatched out only a few reach maturity. The eggs are pelagic, about one-twentieth of an inch in diameter, 406,000 being contained in a quart. The egg is one of the oldest known, being first discovered by the Norwegian naturalist, G. O. Sars, in the 'sixties of the preceding century, when he was investigating the Lofoten fisheries on behalf of his Government. This was the first discovery of the pelagic nature of the eggs of commercially valuable sea fish. The egg has a simple yolk, without oil-globule, and there is only a small space between the yolk and the egg membrane. Of recent years attempts have been made to determine quantitatively the abundance of pelagic eggs of marine fish. A fine-meshed net, the area of the opening of which is accurately known, is lowered to a given depth, say 10 fathoms, and then fished vertically through the water. By means of a calculation an estimate is made of the volume of water fished through, and since the eggs are collected, identified and counted, the number for each species in a given volume of sea water is known. Naturally there is great variation for

the different species in different areas. Sufficient collections, however, have been made in recent years to enable us to form a picture, though necessarily imperfect as yet, of the number of eggs of a species, such as the Cod, in a given area of the sea, say, over the Dogger Bank or in the Western Baltic. These numbers are in many cases enormous. In some cases it is difficult even for a specialist to distinguish the eggs and the early larval stages of closely allied species apart. For instance, the eggs of the Cod and Haddock are very similar when first hatched, and it is only when the embryo has attained a certain degree of development inside the egg that we can distinguish the eggs of these two species with certainty.

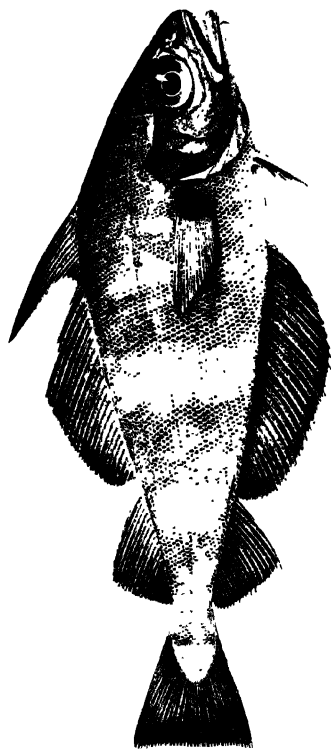
In the shallow waters of the Irish and North Seas the floating eggs of the Cod are not found at all. In the North Sea the chief spawning grounds are in depths from 15 to 50 fathoms, about 20 to 30 fathoms being the depth which the cod principally selects for spawning purposes.

The young new-hatched fry drift into the shallow coastal water all around the North Sea; they are especially numerous in shallow water over the tail of the Dogger and near the coast on the east and north-west of the British Isles; the Moray Firth, in particular, is a favourite spot for cod larvæ. These larvæ are pelagic, but since the adult cod is demersal in its habits, it follows that the young fish at some stage in their life-history seek the bottom. This they do gradually, like all other demersal species with pelagic eggs. The time taken for this descent to the bottom varies in different species of marine fish, but during the descent the larva acquires the adult form and appearance. When first hatched the young cod has no mouth or alimentary canal, and it lives for a time on the food contained in the yolk-sac attached to the abdomen. Probably at or about the time the young reach the bottom, the mouth and food canal commence to function. In the southern parts of the North Sea Cod attain a length of from 7 to 8 inches in their first

year, but in Norwegian waters growth is much slower, and they are only 3 inches long at the same age. Cod may become mature as early as their second year, but usually not until the fourth year. Young cod are known to our deep-sea fishermen as codling, and are spoken of frequently as if they were a distinct species. The codling, however, is certainly nothing but a young cod. Cod at the end of their fourth year, when first mature, are about 2 feet long ; the average length of a spawning cod may be taken to be between that and 30 inches. Cod grow to a length of 5 feet and more, and attain a weight of from 30 to 50 lbs. Like many other sea fish the cod performs definite migrations, mostly for spawning and feeding purposes. In the summer months they migrate offshore into the deeper water of the open sea ; in late autumn and early winter they begin to seek their spawning grounds in water of moderate depths. These migrations do not probably cover any great distance ; though more knowledge is required here, the general tendency of modern opinion is to regard the cod as a fish of restricted range of movements. Cod have been marked with numbered labels and their migrations traced, but not to the same extent as those of the plaice.

The Cod is a predaceous fish living largely on other species of fish, but also not neglecting crustacea, worms and molluscs. The squid is a favourite article of its diet. The following fish seem to be the chief constituents of the Cod's food : Herring, mackerel, haddock and sand eels. The chief bait used by line fishermen for the capture of cod consists of herring, sand eels, squids, mussels, whelks and sand worms. The largest cod recorded was one from the American coast, which, according to Brown Goode, weighed 160 lbs. !

Although the Cod is one of the most abundant of fish and one of the most prolific, attempts have been made to improve the supply in certain localities by artificial hatching. This has been done at Flodevigen, Norway, and to an even greater





extent at Woodshole in the United States. It is doubtful whether these hatching operations exercise much beneficial effect, though they may have some effect in the immediate vicinity of the hatcheries.

Since the war the British fishermen have maintained their supremacy as the chief Cod fishermen of Europe.

The Haddock (*Gadus aeglefinus*).

The Haddock (Plate 55) is easily distinguished from the other members of the Cod family by the large oval black blotch on the side between the middle or posterior half of the pectoral fin and the lateral line. The back is coloured greyish-brown, the belly white. There is a small barbel under the chin.

The Haddock is unquestionably one of the most important of our marine fish, and its fishery has been prosecuted by our fishermen from early times. Consumed either fresh or cured, its flesh is delicious. The celebrated "Finnan" Haddock is well known everywhere. The Haddock differs from its near relative, the Cod, in several respects. The Cod is a predatory species; the Haddock lives mainly on shell-fish and crustacea, though it does not despise small fish at times. The Haddock also swims more together in shoals than does the Cod, and is altogether a smaller species than the latter. The record for a British Haddock is given by Day from Dublin Bay as 24 lbs., measuring 37 inches in length.

The Haddock is a North Atlantic fish of wide distribution, being found on both sides of the Atlantic, but is much more abundant on the European side, where it extends from the Bay of Biscay to 78 degrees North Latitude. All round the British Isles it is abundant, especially in the North Sea. Its abundance diminishes rapidly as we pass down the Channel to the Bay of Biscay. Off the west coasts of Britain and to the north of the North Sea it is common. Our trawlers catch it off Iceland,

the Faroes and Rockall. Even in Barents Sea our hardy fishermen catch it, though the grounds there are not especially prolific of haddock.

The value of the pre-war catch of the various northern European nations participating in the Haddock fishery was about two and a half million pounds sterling. About three-quarters of the total weight was taken in the North Sea. The next haddock grounds in order of importance are Iceland, the Skagerrack, the Faroe Islands, the north-west of Scotland; then south and west Ireland, Barents Sea and Rockall. The lion's share is taken by British fishermen, in an average year about 57 per cent. Haddock forms about 18 per cent. of the total weight of edible fish caught in the North Sea, though naturally there are fluctuations from year to year. If we omit pelagic fish such as herring and mackerel, which are caught by drift nets, and consider only demersal fish, which like the haddock are chiefly caught by trawl and long lines, then haddock forms very nearly half of the total weight of fish caught in the North Sea, from 46 to 47 per cent. So far as the North Sea is concerned, haddock is unquestionably the most important fish for the trawlers; in pre-war money values, the North Sea haddock fishery would be worth about one and three-quarter million pounds sterling.

The market statistics for Aberdeen have been carefully analysed by D'Arcy Thompson, whose papers give much detailed information as to the distribution of haddock of different sizes on the North Sea fishing grounds. These statistics, though too elaborate to be quoted here, are of the greatest possible interest to students of the problems of over-fishing, since Aberdeen is our most important port for the haddock fishery. It is sufficient to state here that there are now five trade classes of haddock landed at Aberdeen: Extra large, large, medium, small and "small small," this last class having only been introduced in recent years. Of these classes "extra

large" are only caught in very moderate quantities in the North Sea ; for this class of fish our fishermen have now to go much further afield, to the north-west of Scotland outside the North Sea, to the Faroes, and best of all to Iceland, where a few years ago enormous catches of extra large haddock were made. This fact in itself is a strong indication of over-fishing, as regards haddock, in the North Sea. The statistics are reduced to weight of fish caught per hundred hours' trawling, but are not quoted here. The second class, the "large" of the trade returns, shows a different result. The North Sea still yields a good proportion of this class, though the best grounds are to the north-west of Scotland and off the Faroes. From the Icelandic grounds few of these fish are brought home by our trawlers, but this does not necessarily mean they are not caught there. Probably they are caught and then thrown back into the sea dead, only selected fish being retained for the home market.

For the smaller classes of fish the statistics are not so reliable, since there is no doubt that large quantities of small haddock are caught by our trawlers and thrown overboard, especially if a good voyage can be made with larger and better fish. The preponderating portion of the North Sea catch now landed at Aberdeen consists of fish of these smaller trade classes. On the whole, and subject to certain reservations, since we are only dealing with the statistics of one market, though that is the greatest in the country, the evidence seems to point strongly to over-fishing of haddock in the North Sea. The statistics for the whole North Sea, when the totals of the various nations participating in the fishing are considered, are so enormous and fluctuate so violently from year to year, that caution must be exercised before coming to a definite conclusion ; but there is little doubt in the writer's mind that the statistics definitely point to a shrinkage of haddock in the North Sea. When there is a large increase in any given year, it is invariably due to the

preponderance of haddock of the smallest classes in the catch, by no means a healthy sign for the future of the fishery. The headquarters of the North Sea haddock is in the central portion of the sea, and here the fish are found in greatest density, both as regards the number of individuals caught and total weight caught per hundred hours' fishing. Dr. Russell, the head of the scientific staff of the Ministry of Agriculture and Fisheries, believes that the supply of haddock in the North Sea is more or less self-contained, and that there is no great interchange between this and other regions. In this respect the haddock is like the plaice, indigenous to the North Sea, spending the whole of its life within its boundaries. The importance of this on the question of over-fishing is obvious. If there is no considerable migration from outside, the necessity for conserving the present stock is imperative.

Of course there is another possibility: it may be there are good spawning years for the haddock as there are good years for potato or wheat crops. The physical conditions in any given year, such as the temperature and salinity of the water or the available food-supply, may either favour or hinder the spawning of the haddock and the development and growth of the young, and it may possibly be the case that these physical and biological changes in the environment exercise a greater influence on the stock of haddock than the utmost man can do with his enormous and powerful implements of fishing to deplete the stock of fish. More information is needed on this and many other points which are still obscure in the life-histories of our important and valuable marine fish. Since the small haddock landed at our ports are about two years old, it follows that favourable conditions for spawning and development of the larvæ in 1924 will be followed by an increased catch of young haddock in 1926, and *vice versa*. For the solution of this and other problems connected with our sea fisheries we have to wait awhile.

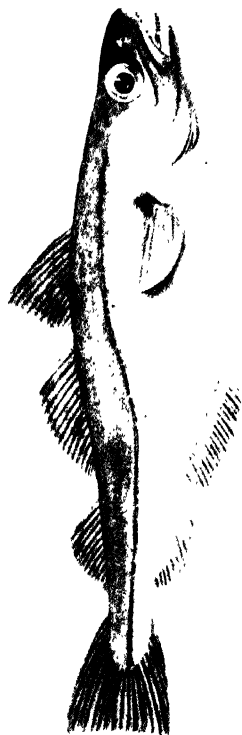
It is well known that the age of fish can be determined from



H. 56.

Norway Pout. (p. 131)
Poutasson. (p. 131)

A 144.



Whiting. 111
Pollack. 112

the study of the scales, which show annual rings of growth. This age determination is, generally speaking, easy for young fish which are only a few years old. In the case of older fish it frequently happens that the later-formed rings are by no means clear, and there is again a great variation in different species of fish. In some fish scale-reading is easy, as in the Salmon; in others it is extraordinarily difficult, if not impossible, to determine the age of the fish by observation of the scales. The Norwegian scientists have of recent years made extensive investigations into the age of haddock by the method of scale-reading. Hjort discovered that haddock of the years 1902 and 1903 were relatively scarce, whereas those born or rather hatched in 1904 were numerous. This scarcity of 1902 fish is reflected in the statistical returns for 1905, when the haddock fishery was a poor one; whereas in 1906, when the 1904 fish began to appear on the markets, the catch was extraordinarily high.

The result of these scale-reading investigations tends to show that the abundance of haddock in any given year is more dependent on a favourable season for the hatching and rearing of the young fish, and that the destruction of the adults caused by man's fishing is only relatively of small importance. Whether this view is the correct one the future alone can determine. It is, of course, also possible that the haddock population of the North Sea may be to some extent recruited by immigration from the Atlantic, but Russell's investigations do not support this view; in fact, they support the contrary opinion, namely, that the North Sea is a self-contained area for the haddock. Some of the Continental investigators are inclined to the immigration theory, and they believe that the haddock supply of the North Sea is maintained by an influx from the Atlantic.

The spawning grounds, eggs and young larvæ of the Haddock have been closely studied of late years. According to the Scottish investigations, the spawning time of the Haddock commences somewhat earlier than that of its close relative,

the Cod. The haddock commences to spawn in the middle of January, and the spawning period is not over until mid-June. The maximum is reached between the middle of February and the middle of March. The southern part of the North Sea is not especially a spawning ground for the haddock, though its floating eggs are found there in minor quantities. The great bulk of the haddock eggs are found on the northern part of the Great Fisher Bank, between 58 and 60 degrees North Latitude, in depths from 40 to 60 fathoms. The haddock also spawns in Icelandic waters, almost invariably in deeper water than the cod. The egg of the haddock is one of the largest of the *Gadoids*. It is pelagic, with homogeneous yolk and no oil-globule; the diameter varies from 1·19 to 1·67 millimetres. The egg is rather difficult to distinguish from that of the cod. Before the young embryo is hatched it assumes characteristic features, and at this stage the egg is not difficult to identify.

Although the eggs of the cod and haddock are frequently taken together in the tow-net, it often happens that where great numbers of eggs are present they belong almost exclusively to one species or the other. The period of incubation is usually about three weeks, but later in the season when the water is appreciably warmer this period is considerably shortened. The number of eggs produced by an adult female is approximately 450,000. Newly hatched larvæ of the haddock have been taken in enormous numbers in tow-nets in the North Sea at precisely the same places as the eggs, but outside the North Sea in localities where eggs are not generally met with.

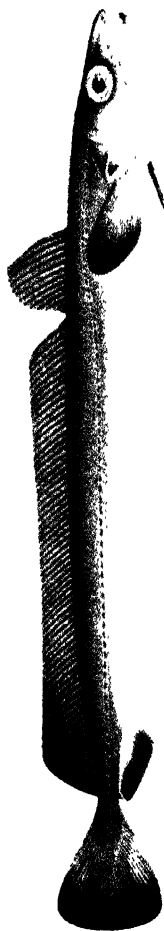
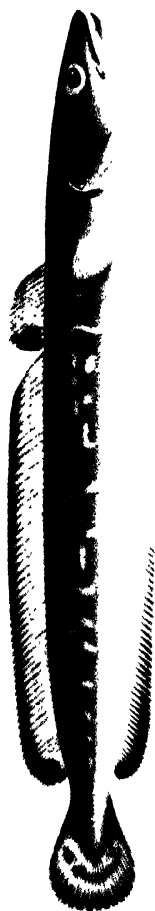
The greatest catches of haddock are made by our trawlers on the spawning grounds. Off our western coasts the haddock spawns from 55 degrees northwards to 67 degrees. Below 55 degrees spawning haddock are not often caught. The western spawning grounds are off Rockall, the Faroe Bank, and off Iceland. For some considerable time the absence of small haddock in the shallow inshore waters in which young cod,



Pl. 58

Coal-fish. (p. 140).
Four-bearded Rockling. (p. 163).

L. 140.



coal-fish and other Gadoids are found was a puzzle to ichthyologists, but it is now known that they are found in deep water in the North Sea and other localities. In other words, the young haddock does not make an inshore migration similar to the cod and whiting. Not only so, but young haddock live in the upper layers for a much longer time than the cod ; their pelagic life is longer. The young larva when first hatched is only about 4 millimetres long. When it has attained a length of from 20 to 25 millimetres its larval life is over and the adult form is assumed. In spite of this the haddock continues to live for some time in the upper layers of waters, whereas most Gadoids and Pleuronectids seek the bottom when the adult form is reached. The young haddock spend the first two years of their life in the open sea. In their third year in the North Sea they seek the shallower grounds in the south and east. They move in shoals, consisting of individuals of approximately the same age and size. It is probable that there are certain periodic movements and concentrations of these shoals for feeding and spawning purposes, especially a movement southwards in the summer-time and a return northwards in the winter.

At the end of the third or fourth year the haddock becomes sexually mature, and then seeks the spawning grounds mentioned above.

The haddock prefers muddy or sandy ground, feeding principally on crustacea and molluscs, echinoderms and worms.

The black blotch on the side of the haddock (and on the John Dory as well) is popularly supposed to represent the mark of the finger and thumb of St. Peter when he drew the fish out of the Lake of Gennesaret to obtain the piece of tribute money. Neither of these two species is, however, found in this lake.

The Bib or Pout (*Gadus luscus*).

The Bib, Pout, or Whiting Pout (Plate 54) is a denizen of the north-east Atlantic. By no means an uncommon species on the west coast, it is frequently taken in the trawl, and also by rod and line by sea anglers. It seems to be commoner in the Channel and off the coasts of France, Spain and Portugal, entering the Mediterranean. It may be considered as a southern species of the Gadoids, as it is much rarer in the northern part of the North Sea. Smaller than the Cod or Haddock, it is characterised by the very deep body, which is copper-coloured with broad upright bands. A barbel is present. It spawns in the Channel from January to March or April, in 25 fathoms, that is, in moderately deep water. The egg, like that of all other Gadoids, is pelagic. It has no oil-globule. Artificial impregnation and hatching have been accomplished by Ehrenbaum. The egg is 1·14 millimetres in diameter, and the incubation period from 10 to 12 days. The embryo, four days after development commences, bears a striking resemblance to that of the Flounder. When hatched the young fish may be recognised by the fact that the posterior third of the body is free from pigment. The larvæ have a short pelagic life-history and soon drift inshore. Larvæ are common in the Channel but rare in the North Sea, so that presumably the Bibs which annually appear along the east coast of Scotland and the North of England, with the Cod and Haddock, migrate from the south.

The Bib rarely exceeds a weight of 5 lbs.

The Poor Cod (*Gadus minutus*).

This is the smallest and most widely distributed of the Gadoids. It is not so deep in the body as the Bib or Pout; the vent is farther back. The colour is brownish-yellow on the back, and there are no bands. A barbel is present (Plate 54).

The Poor Cod ranges from Trondhjem to the Mediterranean. It is common all round the British Isles and is frequently taken in the trawl. It extends into the Cattegat to the Sound. The spawning period is from March to June. The spawning grounds are in the Channel, Bay of Biscay, and off the west coast of Britain in depths of 50 fathoms and over. The eggs are small, without oil-globule, and closely resemble those of the Flounder. Like all species which spawn late, the development is rapid. The fry drift towards the coast and are found in relatively shallow water. From a pelagic length of 0.5 centimetre they attain a length of $1\frac{1}{2}$ to $2\frac{1}{2}$ centimetres by the time they arrive at the bottom close inshore. They are distributed along the north-east Atlantic coast, from the Bay of Biscay to the south of Norway, in depths up to 30 fathoms. Little is known of their migration and growth.

The Coal-fish (*Gadus virens*).

The Coal-fish, or Saithe (Plate 58), is distinguished from the other species of the genus *Gadus* by its dark colour. It ranges from the Arctic Ocean to the Mediterranean, though it is more particularly a northern fish. Of late years it has formed an appreciable portion of the catches of our steam trawlers, and owing to its low price is a popular food, entering largely into the consumption of "fried-fish" shops.

The Coal-fish spawns from January to May in depths of from 50 to 100 fathoms, and is, like the Hake, a typically deep-water fish. The chief spawning grounds are in the North Sea, Atlantic and off the Norwegian coast. The eggs are similar in character to those of the Cod but smaller, being scarcely more than $\frac{1}{3}$ of an inch in diameter. The eggs only float in water of 35 per mille salinity, that is, in oceanic water. Very soon after spawning, both the large Coal-fish and their eggs completely disappear from the spawning grounds

The period of incubation is nine days at 43° F., or six days at 49° F. ; that is, about a week less than the Cod. This agrees with the general rule that in allied species the smaller the egg the shorter the incubation period. Coal-fish go to the bottom much quicker than the Cod. The fry drift shoreward early in summer. The young stages, as in the case of other allied species, live principally on small crustacea, while the older fish devour other species, particularly the herring. The rate of growth varies enormously ; in suitable waters it is fast and regular. The farther south the species live the more rapid is the growth. It is probable that the Coal-fish migrates to considerable distances, and oceanic currents distribute the fry far and wide, and hundreds of miles of coastline are dependent for their supply of this species upon successful spawning in distant waters and at comparatively great depths.

The Whiting (*Gadus merlangus*).

The Whiting is easily distinguished by the absence of a barbel, by its silvery sides, and the black spot above and about the root of the pectoral fin (Plate 57).

It ranges from Norway to the Mediterranean and forms an important constituent of the British trawlers' catch, an average year yielding about 30,000 tons. The bulk is taken from the North Sea, about 87 per cent. of the total ; while over 90 per cent. is taken between 10 and 20 fathoms, and 40 per cent. between 20 and 30 fathoms ; so that, compared with other members of the Cod family, it is a typical shallow-water species. Its food consists principally of fish and crustacea, herrings and other whiting, the common shrimp and red shrimp being abundant in the Whiting's stomach. There is as yet no evidence of over-fishing, and the species is quite common in all depths off our coasts up to 30 fathoms. It spawns in depths from 10 to 30 fathoms, that is, in much shallower waters than either the Cod

or the Haddock. The spawning grounds may be met with anywhere off the British Isles within those depths, and the period of spawning is from February to June. The eggs resemble those of the Cod and Haddock but are smaller, averaging 0·047 inch or 651,000 to the quart. The fish spawn easily in confinement in aquaria. The young larva is about one-tenth of an inch long. The identification of the eggs and larvæ of closely allied species, such as the Cod, Whiting and Haddock, is a matter of some difficulty because of the close similarity which obtains. At lengths of an inch or slightly longer, a small but distinct barbel is present ; this disappears later in life. As the larvæ reach the 5-fathom line they sink to the bottom. Young whiting are found in great abundance close to the shore, especially in sandy bays and estuaries. Together with young plaice they frequent the shrimping grounds of the Lancashire coast, where they are destroyed annually in their thousands by the operations of the shrimpers, particularly during July and August. Whiting are first mature at a length of 9 inches, that is, in their second winter.

The Norway Pout (*Gadus esmarkii*).

This small member of the Gadoid family (Plate 56) was formerly thought to be absent from British waters, and it is not recorded by Day. Of recent years it has been recorded in enormous numbers in the North Sea, and must be regarded as a British species. Typically it is a denizen of the north-west Atlantic, being found in the North Sea north of the Dogger Bank and off the north and west coasts of the British Isles. It ranges from the Faroes to Trondhjem. Holt captured a ripe female off the Arran Islands in April, 1891, and the floating eggs have also been taken in Cleggan Bay in the same neighbourhood. Wherever found the Norway Pout is in great abundance. It spawns in the open sea, in the North Sea

from January to April, at depths of from 40 to 50 fathoms. The planktonic egg is very small (1 to 1·08 millimetres in diameter) and has no oil-globule. The young, when hatched, are also very small, and the pelagic existence tends to be prolonged. Newly-hatched larvæ only measure 3·2 millimetres. In the first year the young reach the bottom in July, when they are from 6 to 7 centimetres long. Fulton found, by placing a small-meshed net over the tail end of a trawl, that the Norway Pout are quite common in Scottish waters, and he reports numerous specimens from the Shetlands, Aberdeen Bay, the Moray Firth, and Firth of Forth. It has also been found in the stomachs of hake caught beyond the entrance to the Bristol Channel and landed at Plymouth (Holt).

The Pollack (*Gadus pollachius*).

The Pollack (Plate 57) resembles the Coal-fish, but is dark green above and not blackish, the belly silver-white with yellow markings. The lower jaw is longer than that of the Coal-fish. There is a small barbel in the Coal-fish, but none in the Pollack. The lateral line in the Pollack is dark and strongly curved over the pectoral fin ; in the Coal-fish the curve is very slight and white in colour, the lateral line being practically straight. Like the Coal-fish, the Pollack prefers rocky ground. The Pollack is of more southern distribution than the Coal-fish, ranging from Trondhjem to the Mediterranean. In British waters it is most abundant on the west and south-west coasts. In more northern waters it is rarer, but is nevertheless found at the Orkneys and Shetlands. At the Faroes it is only occasionally met with, and at Iceland not at all. In the Baltic it extends as far as Mecklenburg.

The Pollack, although a fish of wide distribution, apparently spawns in rather restricted areas, but although the spawning fish have frequently been captured, the egg and young stages

are not so well known as those of other Gadoids. The egg is pelagic, and resembles that of the other Gadoids in being devoid of an oil-globule. It is nearly the same size as that of the Whiting and Coal-fish (from 1·10 to 1·22 millimetres in diameter), which it closely resembles. The earliest larval stage has not been identified with certainty.

The Pollack spawns from February to May, and the chief spawning grounds so far discovered are in the western part of the English Channel and off the Hebrides, in depths of 50 fathoms or slightly less. The young Pollack are believed to make considerable migrations before they attain any appreciable size, since the young fish met with in the southern part of the North Sea are certainly not spawned there, but come in from the English Channel.

When young the Pollack feeds on crustacea, worms and molluscs. The older fish live on other fish, such as sand eels, sprats, herring, pilchards and gurnards.

The Pollack attains a respectable size; fish of 6 or 7 lbs. are common, and specimens of 12 and even of 24 lbs. weight have been recorded. The flesh is considered to be of good taste, but in the writer's opinion it is inferior to that of other Gadoids. Only in the English fishery statistics are the weight and value of Pollack given separately.

The Poutassou (*Gadus poutassou*).

The Poutassou (Plate 56) may be distinguished by the fact that the outer row of teeth in both jaws are enlarged. The lower jaw is slightly longer than the upper. The body is narrow and silvery. The Poutassou is one of the smaller Gadoids, attaining a length of from 30 to 40 centimetres. Since it is a western and southern fish and its habitat the open ocean, it is rarely seen in British waters. It ranges throughout the north-east Atlantic from Finmark and Iceland to Gibraltar,

and is found in the Mediterranean. Young stages are not uncommon in the Channel. It is probable that the adult fish is not quite such a demersal liver as the other gadoids, and consequently it is but rarely taken in the trawl. It is, at any rate, certain that the young fish—up to 15 centimetres in length—live in the upper layers of the water.

The spawning period is probably in the spring, and the spawning grounds are in the open ocean, ranging from off the Faroes to the Bay of Biscay in depths of about 500 fathoms. The eggs have not yet been described. The youngest larvæ so far identified were obtained by Schmidt in the open ocean at the surface, where the depths were from 500 to 700 fathoms, and were captured in May and early June. These young larvæ are much like those of the Whiting. Couch states that multitudes of the young fish, about 5 inches long, occur off the English coast in July. Holt met a shoal of young Poutassou off Achill Island, 34 miles from the coast, in July, 1890. They were apparently living near the surface, and had not come from any considerable depth. They were feeding on minute crustacea (copepods) and other pelagic members of the plankton. Couch obtained a specimen 15 inches long in May, probably two or three years old.

There seems little doubt, then, that while the adult fish is oceanic, and either demersal or living at great depths, the young are pelagic and to some extent migratory, approaching the coast in summer. Fulton records eighty-three specimens taken in September, 1900, off Sumburgh Head; and in January, 1902, he caught one 8½ inches long off the Firth of Forth, while the same year Holt got one 37 centimetres long off the west of Ireland.

The Silvery Pout (*Gadus (*Gadiculus*) argenteus*).

This small Gadoid has a very similar distribution to the Poutassou. It is a species of the deep-water north-east Atlantic,

occurring in the Mediterranean and north and west of the British Isles to the Faroes. Its favourite habitation is between 100 and 500 fathoms; that is, the slope at the extremity of the continental shelf on which the British Islands are situated. It is more a bottom-living species than the Poutassou, and is distributed right out into the open ocean, being recorded from the Iceland-Faroe ridge and the British Isles.

The spawning period is in the spring, and the place is the 500-fathom line from the Faroes to the Bay of Biscay. The eggs are unknown. The youngest known larva is 4 millimetres long. At a length of 36 millimetres its pelagic life is at an end and it sinks to the bottom, where the rest of its life is spent.

A specimen was washed up on Aberdeen sands in April, 1885 (Sim). Fulton gives five records for Scottish waters for 1900: three off Sumburgh Head and two off Fair Isle; also off the Shetlands, and a specimen 10 miles off Aberdeen in 1901. One was also taken 80 miles west-north-west of Cleggan, County Galway, in May, 1905. Frequent in fine meshed nets attached to trawls, 100–200 fathoms, west of Ireland.

The Ling (*Molva molva* or *vulgaris*).

In the Ling the body is elongate and covered with very small scales (Plate 59). There are two dorsal fins, a separate caudal and one anal. The first dorsal fin is short, the posterior one long. There are several large teeth on the lower jaw and on the roof of the mouth on the vomer. There is a barbel on the chin. The ling is a valuable commercial species. It is typically a north-east Atlantic species and is common to the west of the British Isles, extending from Iceland, Faroes, and the Murman coast to the Bay of Biscay. Its usual length

is from 4 to 6 feet, but it sometimes attains a length of 7 feet. The Ling feeds almost entirely on other fish, chiefly on mackerel, megrims, dabs and haddock.

The Ling spawns in the North Sea from March to June, the chief period being April. In Icelandic waters it spawns a little later. The spawning grounds are somewhere in the neighbourhood of the 100-fathom line, though it may spawn in depths as low as 50 fathoms. It is a typical deep-sea fish. The pelagic egg is small, slightly over a millimetre in diameter ; it contains a large oil-globule of pale green colour. The larvæ hatch out in about ten days ; when hatched they have their heads bent downwards, and in this respect resemble the Burbot. The pelagic life of the larvæ is short ; they soon desert the surface layers. The young fish pass through an interesting post-larval stage in which the pelvic fins are greatly elongated. During this stage they are found in mid-water, from 20 to 50 fathoms below the surface, in summer and autumn. They reach the bottom and take on the demersal mode of life at the end of the year, when they are nearly 8 centimetres long. The following summer the young are found inshore measuring about 18 centimetres. The egg and pelagic larvæ of the Ling drift with the current at or near the surface ; in the later larval and post-larval stages the young fish lives at a greater depth in mid-water, and thence continues its migration inshore. The Ling is the most prolific of all fish, and Day gives an instance of a fish weighing 100 lbs. which was estimated to contain 160 million eggs.

The Blue and Mediterranean Lings.

It is doubtful whether we are justified in considering these as British species, since at the most they are only occasional visitors to our shores.

The Blue or Lesser Ling (*Molva byrkelange* Coll. : Plate 59)

inhabits the deep water west of the British Isles and Norway. It is sometimes landed by trawlers who have been fishing the northern grounds and off the Faroes. It is a much smaller species than the common Ling. The eggs are unknown, but it probably spawns in deep water, at 500 fathoms, in the open Atlantic in May or June.

The Blue Ling is the object of an important fishery in Norway. Young post-larval stages, from 6 to 78 millimetres long, have been obtained by Schmidt north and north-west of the Hebrides in depths from 350 to 1,200 fathoms.

The Mediterranean Ling (*Molva elongata*) has even less right to be included in the British fauna than the Blue Ling. As its common name indicates, it is pre-eminently a Mediterranean species; in the Atlantic it ranges north at least as far as the latitude of Ireland, off the coasts of which it has been found in deep water. This species is much more eel-like than the other lings. The eggs and younger larval stages are unknown, but Schmidt has described young stages from 25 to 60 millimetres long which were captured in great depths south-west of the British Isles.

The Hake (*Merluccius vulgaris*).

The Hake (Plate 61) is a large-scaled member of the cod family, the colour of which on the back is brownish-grey with dark spots. The sides and belly are silvery-white. There is no barbel. The fins have a black margin, and the mouth is usually black.

The Hake, which was formerly discarded as worthless by our trawlers, is now a common and well-known fish in our markets, where it deservedly enjoys a high esteem.

A typically deep-water species, the Hake ranges from latitude 20° north off Cape Blanco in Africa, to 62° north near Trondhjem and the Faroe Islands. It also extends throughout

the Mediterranean. In the North Sea the Hake is not taken except at times in summer, but in the deep water of the Skagerrack is abundant in May and June. The Hake has been captured in water up to 400 fathoms in depth and is a true oceanic species preferring water between 48° and 50° F. with a salinity of 35.20 per thousand. The disappearance of the Hake from the North Sea in winter points to its being a fish of migratory habits. There was an early sea fishery off the Irish coasts and the west coast of England for a fish called the "Merluce" or "Sea Luce," carried on by Danes as early as the ninth and tenth centuries. The Spaniards, and later the Dutch, paid large sums to the English crown for the right to participate in the fishery for "Merluciones." Ehrenbaum considers that this fishery was certainly for the Hake; other authorities think it was for the Haddock or Whiting. The word "Merluciones" would seem to apply more to the Hake than either of these two species; but, on the other hand, it is difficult to see how a deep-water fish like the Hake could be caught in any considerable quantity by the primitive vessels and implements of the fishermen from the ninth to the sixteenth or seventeenth centuries. The deep waters off our western coasts, and right down past the Bay of Biscay and the Spanish and Portuguese coasts to Morocco, are the home of the Hake, which for Spanish and Portuguese fishermen plays the same rôle that the Cod does in more northern waters. On the American side of the Atlantic the European Hake is not found, though there is a closely allied but distinct species there.

With regard to the Hake fisheries, England takes far and away the largest share, the catch in an average year being somewhere between 35 and 40,000 tons. The grounds from which this enormous quantity of hake is captured naturally vary to some extent from year to year; in 1907 no less than 88 per cent. was caught off the south of Ireland. The Hake spawns in water from 50 to 100 fathoms deep, and while on the





Hake.
Greater Fork-beard. (p. 177).
(p. 178).

spawning grounds it is captured in enormous quantities by our steam trawlers. A dozen years ago anyone who had suggested that the Hake grounds could be over-fished would have been laughed at, the supply being regarded as inexhaustible. But during the last few years our trawlers have found it increasingly difficult to supply the demands of the home markets for this much appreciated fish, and our deep-sea fishermen now complain that the Hake is in danger of becoming extinct. While this is far from being the case, there is no question but that the Hake is relatively scarce on grounds where it was formerly present in overwhelming quantities. Whether this is due to over-fishing or to annual fluctuation is not yet clear. The eggs, larvæ and life-history of the Hake are well known.

The eggs of the Hake are pelagic, small, 0·03 of an inch in diameter; 1,140,000 are contained in a quart. A single oil-globule is present. Hake eggs have been taken in the tow-net in the North Sea off the Jutland outer grounds, where the Hake spawns late in summer. This, however, is not an important spawning ground as the Hake spawns mostly off our west coasts, and from the Faroes right down to the Bay of Biscay. At a temperature of 55° F. the larvæ have been hatched artificially in less than three days, but growth and development are probably slower under natural conditions. The Hake is a summer spawner; the larvæ have been taken at the surface over water varying in depth from 50 to 500 fathoms, but the chief spawning places are probably within and near the 100-fathom line. The food of the young larvæ, after the yolk-sac has been absorbed, consists of small crustacea known as copepods. Probably these young hake do not live long at the surface; already, when between 3 and 4 centimetres long, they have been taken on the bottom to the south-west of Ireland. Quite possibly the Hake changes its habitat from time to time, now living on the bottom, at another time in intermediate

depths. At any rate, young hake are regularly taken in mackerel drift-nets off the south-west of Ireland.

The Hake becomes mature at a length of 8 inches; it attains a weight up to 20 lbs. and over. Sometimes called the "Sea Pike," the Hake is a voracious feeder, living on other fish, such as herring, pilchards and mackerel.

On the whole there is some evidence that, in recent years, the Hake is diminishing rather rapidly, but whether this is a result of over-fishing on the Hake spawning grounds or whether it is due to natural fluctuations is not yet certain.

The Greater Fork-beard, or Forked Hake (*Phycis blennoides*).

The Greater Fork-beard, or Forked Hake (Plate 61), is distinguished easily by the fact that the pelvic fin forms a long forked filament extending behind the vent. The body is moderately long, covered with small scales. Two dorsal fins, one anal and one caudal, are present, the latter being separate from the dorsals. The anterior dorsal is composed of from eight to ten rays. There are small teeth on the jaws and on the roof of the mouth on the vomer. There is a barbel on the chin. The genus *Phycis* is represented in the North Atlantic by several species, of which only one—the Greater Fork-beard—enters into the British fauna. There are at least two species on the European side of the Atlantic and three on the American side. The Forked Hake is a typical deep-water and oceanic species, and migrates from the Atlantic to south-west Britain, and the North Sea in winter. Little is known of the spawning habits, since in northern European waters the eggs and young forms have never been identified with certainty. Larvæ have been described by Emery, but it is quite likely that he was mistaken, and that the forms he describes belong really to another species. At any rate, we can only be certain of a fairly

advanced post-larval stage when the fish is already 4 centimetres long. The pelvic fins are elongated, as in their near allies. This fish certainly spawns in the open ocean, and the eggs and larvæ may drift into shallower water than where they were spawned. In April, 1895, three specimens were captured off the west coast of the Orkneys, the largest of which measured 17 inches.

The Burbot (*Lota vulgaris*).

The Burbot, or Eel Pout (Plate 60), is remarkable as being the only fresh-water member of the Cod family. In the Burbot the body is elongate, subcylindrical anteriorly and compressed posteriorly. The dorsal fin is composed of many rays, and is divided into a short anterior and a long posterior portion, the latter opposite the anal and, like it, continuous with the rounded caudal fin. The Burbot is found in the fresh waters of northern Europe; England south of Durham, but not Scotland or Ireland. It is common in Continental lakes and rivers, especially towards the east, and extends to the Italian lakes, to the rivers of the Black Sea and Northern Russia. It is found in the brackish waters of the Upper Baltic. Its nearest salt-water relative is the Ling. It spawns from December to March.

The eggs, which lie on or near the bottom, are either yellow in colour or transparent, measuring 1·05 to 1·14 millimetres in diameter. They contain a large oil-globule, and in fact closely resemble the pelagic eggs of the Cod family. At a temperature of about 40° F. the young larvæ hatch out in from four to five weeks. When nearly hatched they have the head bent downwards, just as in the larvæ of the Ling. At the age of one year the Burbot attains a length of from 9 to 12 centimetres.

The Lesser Fork-beard (*Raniceps raninus*).

This species, which is also known as the Tadpole-fish, or Trifurcated Hake, has two dorsal fins, but the first is very small and rudimentary (Plate 62). The head is flattened and fleshy. The body is of moderate length and covered with minute scales. There is a separate caudal fin and one anal fin. The pelvics are composed of six rays. There are card-like teeth in both jaws and in the roof of the mouth on the vomer.

The fish is a coastal form of the north-east Atlantic from Trondhjem to the English Channel. It is common in Norway and rarer round the British Isles, preferring a rocky coast. It spawns near the coast from the middle of May to the beginning of September. The eggs are small, with a small oil-globule, and about 0·8 millimetre long. Pelagic fry have been found in the Moray Firth in October, and off the south-west of Ireland in August and September. They have long pelvic fins.

The Three-bearded Rockling (*Motella tricirrata*).

The Rocklings are forms in which there are no separate first dorsal fins, but the front part of the single dorsal is a narrow fringe, more or less concealed in a longitudinal groove. The body is elongate and covered with minute scales. An anal fin is present. Ventral fins composed of from five to seven rays. A band of teeth in the jaws and also on the roof of the mouth on the vomer. In the Three-bearded Rockling there are two barbels on the upper lip, and one on the chin (Plate 63). The adult fish is marked with black or brown round spots. This species extends from the Mediterranean and Madeira to the British Isles, and occasionally specimens are taken in Norway. There is a great similarity between the eggs and young of the different species of Rockling, and they are consequently hard to distinguish apart. The eggs of the Three-bearded Rockling have been artificially fertilised by Raffaele,

and the young stages described by him. Later stages of the young rocklings are very abundant at the surface of the sea in summer, but they are not easily identified until the barbels appear. Young rocklings are of a silvery colour, and were at one time thought to be a distinct species, being described as *Couchia argenteola*.

The Five-bearded Rockling (*Motella mustela*).

The Five-bearded Rockling is distinguished by a pair of barbels on the anterior nostrils, a pair on the upper lip, and one below the chin (Plate 63). There are no spots on the body. The species attains a length of 18 inches. This fish differs from the other members of the genus in being a coastal form, and is of not such wide distribution as the Four-bearded form, being absent from the Baltic and American coast. It ranges from Portugal to Iceland and Finmark, and prefers a sandy or rocky bottom. It spawns near the coast, sometimes even in brackish waters; the time being from January to June. The eggs are small, of the same size as the Four-bearded Rockling, and possess a feebly coloured oil-globule. Brook hatched out the larva in his aquarium in 1884, in from five to six days. The young larvæ, like those of the Ling and other allied forms, have the pelvic fins greatly elongated. Later they assume a silvery appearance, and are known to the fishermen as "Mackerel midges." At a length of 4 centimetres they lose their silvery appearance, abandon their pelagic life and sink to the bottom. The young of this species passes its first year inshore.

The Four-bearded Rockling (*Motella Cimbria* or *M. macrophthalma*).

This species is distinguished from the preceding by the fact that it has an additional barbel on the upper lip in front of the

other pair, and this with the barbel at the chin makes four in all (Plate 58). The Four-bearded Rockling has no spots, and has not been recorded above 14 inches in length, whereas the three-bearded form grows to 20 inches.

The Four-bearded Rockling ranges in the north Atlantic from Norway to Cornwall on the east side, and the west side to Florida. It is a typically deep-water form. In the young stage it is common in the North Sea beyond depths of 30 fathoms. This species probably spawns wherever it is found from February to August. The eggs are very small, from 0·6 to 0·8 millimetre in diameter. They are provided with a greenish or yellow oil-globule. The newly hatched larva is very small, being only 2 millimetres in length.

The Torsk or Tusk (*Brosmius brosme*).

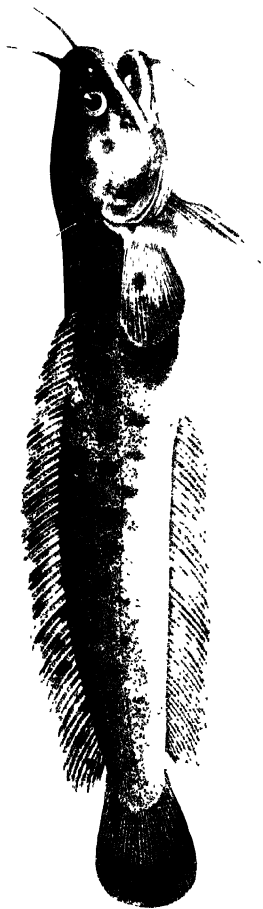
In this species there is one long dorsal and one long ventral fin (Plate 62). The body is moderately elongate and covered with very small scales. The caudal fin is separate. The ventrals are narrow and composed of five rays. There are teeth on the palate and on the vomer. A barbel is present. In an average year about 2,400 tons of this fish are landed by British trawlers. It is a typically north Atlantic species of wide distribution, ranging from Cape Cod on the American side northwards to Greenland. It is taken off Iceland, the Faroes, and Shetlands, and also on the north coasts of the British Isles, in the northern North Sea, and off the Norwegian coast. A deep-water fish, residing between the 100 and 200 fathom line, it spawns in April, May and June. The eggs were first described by McIntosh from specimens artificially fertilised at the Shetlands. They are rather large, from 1·3 to 1·5 millimetres in diameter, and with an oil-globule of a reddish tint. The spawning places are probably in 50 to 100 fathom water off the south and west of Iceland, the Faroes, west and north



M 164.

Lesser Fork-beard.
Torsk.

N. 62.



P. 63.

Three-bearded Rockling. (p. 162)
Five-bearded Rockling. (p. 161)

M 165.

of Scotland, and off the coast of Norway. Hatching takes place on the ninth day and the young have elongated pelvic fin rays. The young stages are found in relatively shallow water. Most of the pelagic fry are obtained at a depth of 10 to 15 metres below the surface. The Torsk grows to a length of 3 feet, the record being $3\frac{1}{2}$ feet.

THE SAND EEL FAMILY (Ammodytidae).

The Sand Eels, or "Launces," have no pelvic fins. The body is elongated and the vent remote from the head. The gill openings are very wide, the gill-membranes not united.

Sand Eels are gregarious fish, being found in shoals in coastal waters, where they are frequently taken in sandy bays in the shrimp trawl. They are used both as food and as bait for other fishes. According to Gunther, their presence is discovered by watching the action of Porpoises which feed on them. These Cetacea, when they meet a shoal, know how to keep it on the surface by diving below and swimming round it. There are two species of British Sand Eels, not very easily distinguished apart.

The following characteristics serve to separate them.—

Grows to 12 inches. Two strong teeth in roof of mouth on vomer. Commencement of dorsal behind hinder extremity of pectoral.

Greater Sand Eel (*A. lanceolatus*).

Grows to 7 inches. No teeth on vomer. Commencement of dorsal is above pectoral fin.

Lesser Sand Eel (*A. tobrianus*).

The Greater Sand Eel (*Ammodytes lanceolatus*).

This is a typically north Atlantic coastal species, ranging from the Murman coast to the Bay of Biscay. It is found all round the coasts of the British Isles, but is not nearly so common as the Lesser Sand Eel. It spawns from May to July or even August, and the eggs and young stages closely resemble those of the Lesser Sand Eel. The eggs are demersal and adherent, and provided with a single large greenish-yellow oil-globule. The period of incubation lasts from two to three weeks.

Sand eels feed largely on young sprats, and on the young of their own species as well as crustacea. They are closely allied to the Cod family, from which they are distinguished by the following characteristics. The greater length of the body; the vent is situated behind the middle of the body, so that the anal fin is short (Plate 64); the absence of pelvics is another prominent feature. The lower jaw projects into a spoon-shaped process beyond the upper jaw, and by means of it the sand eels are able to burrow in the sand. They are frequently dug up from the sand between tide-marks.

The Lesser Sand Eel (*Ammodytes tobianus*).

The Lesser Sand Eel (Plate 64) extends from the Bay of Biscay right along the North Atlantic coasts of Europe up to the White Sea, Iceland, and is also found in Greenland. In the Baltic it is found up to Finland. It is common and abundant all round the British coasts, spawning in autumn in the southern North Sea in depths from 10 to 40 fathoms. The eggs are irregularly oval in shape, are demersal and adherent (Plate 106). They are fastened to sand-grains on the bottom, but may become detached by currents and float. Larvæ are found occasionally at the end of the year; in spring they may be obtained in large numbers. It is probable that the Sand Eel, like the Herring,

has two spawning periods in the year, about June and December being the maximum periods respectively. The female is usually larger than the male; she produces from 10,000 to 30,000 eggs. The ripe female bores its way through loose sand below low-water mark, and whilst doing so discharges its eggs. The egg is of nearly the same size as that of the larger Sand Eel, and, like it, is provided with a single large oil-globule, which however has a dull golden and not a greenish colour. The life-history has been studied in detail by McIntosh. When hatched the young larva is from 4 to 6 millimetres in length, and at this stage the yolk is exhausted, the oil-globule alone remaining. The post-larval Sand Eel remains at the bottom until it reaches a length of about 10 millimetres. At this stage it may be observed in countless thousands in suitable rock pools left by the tide, and it is often accompanied by numbers of larval and post-larval herrings. The elongated larval stages of the Herring and Sand Eel are not unlike. The young Sand Eel now begins to move upwards into mid-water, and its growth is very rapid. The average date for this migration is about the end of April, and by the third week in May the young Sand Eel is found living at the surface. Vast shoals of sand eels may be seen in our bays in quiet summer weather, swimming about a fathom below the surface. They serve as food for other fish, and are preyed upon by most diving birds.

THE OPHIDIIDÆ.

In this family of fish the body is more or less elongate, naked or scaly. The vertical fins are generally united, the dorsal not being separate from the anal. The dorsal fin occupies the greater part of the back. There are no pelvic fins, and the vent is at the throat. For the most part southern species, there are two representatives which wander occasionally

into British water. These are the Bearded Ophidium (*Ophidium barbatum*) (Plate 64) and the Fierasfer (*Fierasfer dentatus*). They are for the most part shore fishes. The Bearded Ophidium is missing entirely in northern waters; a few stragglers have been recorded from the Channel. It is mainly a Mediterranean and Atlantic species. The eggs of the ripe female are embedded in slime and show a tendency towards an ovoid shape.

The species of Fierasfer are remarkable for seeking shelter in Sea Cucumbers (*Holothurians*), or even in Echinoderm or Molluscan hosts. Up to the present there are only about three or four records of adult specimens of Fierasfer in northern waters, the species being a typical Mediterranean form. Day gives two Irish and Sim a Scottish record (1883) for *Fierasfer dentatus*. There is one record for *Fierasfer acus*, which was dredged up in deep water off the west coast of Scotland by Sir John Murray in 1889. The planktonic larvæ and young forms are, however, not so rare in our waters as the adult appears to be. The eggs and young of a closely allied form (*Fierasfer acus*) have been described by the Italian zoologist Raffaele. The eggs are pelagic and embedded in masses of slime. Similar masses of slime with eggs have been attributed to *Fierasfer dentatus*, and these have drifted northwards into British waters. The larvæ have been taken off the south-west of Ireland, in the Faroe Channel, and on the Great Fisher Bank. The eggs described by Holt from the Irish coast as belonging to this species are, however, the eggs of another fish, *Trachypterus*. *Fierasfer dentatus* spawns off Naples in March, but the eggs have not been found in British waters. Young larvæ from 6 to 10 centimetres in length have been taken off the Great Fisher Bank in the middle of the North Sea. Very young larvæ have been captured by Holt in 14-fathom water off the entrance to Cork, and a similar stage has been recorded by Fulton on the 8th October, 1903,

about 185 miles east by north from Aberdeen. It was captured near the surface in a tow-net. McIntosh has described larvæ taken off Valentia in 1898 and now in the Dublin Museum; and six specimens of the young were taken on the shores of the Moray Firth in March, 1862. The fish forces its way into its host, the *Holothurian*, through the cloaca, passing in tail first, taking advantage of the respiratory movements in so doing. The Fierasfer thus gains shelter and feeds on the plankton brought in by the respiratory current of its host. Several Fierasfers may enter the same host, and this frequently results in its death. They come out partially to discharge the intestine, which is situated far forward, and in this position the Fierasfer attempts to feed. They also come out at night periodically to feed. The larva of Fierasfer is distinguished by a process which develops at the posterior end of the head, and which soon extends into a long filament bent at right angles, having at its extremity foliate expansions. This is a greatly developed first ray which serves as a sensory organ. This appendage shortens and finally disappears before the free pelagic life is ended.

HETEROSOMATA (Flat-fish family).

The body is strongly compressed laterally, so that the fish is flattened, with one of its sides coloured, the other colourless. Both eyes are on one side of the body. The dorsal fin extends forwards as far as or beyond the eyes, but along the edge of the head, not between the eyes.

There are four main groups of British Flat-fish :

Species with the eyes on the right side. Teeth most developed on blind side. 1.

Species with the eyes on the left side. Mouth large. Jaws similar on two sides. 11.

Species with the eyes on the right side. Teeth only on blind side. A "beard" on lower side of head. III.

Species with the eyes on left side. Teeth and jaws equal on both sides. IV.

The first group includes five British species, all formerly of the genus *Pleuronectes*, but now divided into several genera.

They may be readily distinguished by the following characters:—

Lateral line almost straight. A spine before the anal fin.

Head large. Plaice (*P. platessa*).

Lateral line almost straight. A spine before the anal fin.

Head very small. Lemon Sole (*P. microcephalus*).

Lateral line almost straight. No spine before the anal fin.

Blister-like cavities beneath skin on lower side of head.

Witch (*P. cynoglossus*).

Lateral line strongly curved anteriorly. Dab (*P. limanda*).

Lateral line slightly curved anteriorly. Opaque white under and black upper surface. Rough tubercles along base of fin and along lateral line. Flounder (*P. flesus*).

The second group includes two British species belonging to two genera:

Scales smooth. Lateral line curved. Size very large.

Halibut (*Hippoglossus vulgaris*).

Scales rough. Lateral line straight. Size very small.

Long Rough Dab (*Hippoglossoides limandoides*).

The third group comprises four British species of the genus Solea:

Pectoral fins well developed. Nostrils on blind side not dilated. Sole (*S. vulgaris*).

Pectoral fins well developed. One nostril on blind side dilated. Sand Sole (*S. lascaris*).

Pectoral fins very small. Body banded on coloured side.

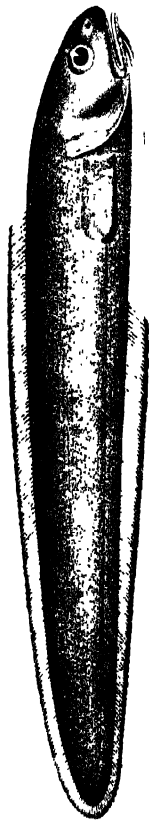
Thick Back (*S. variegata*).



1



2



3

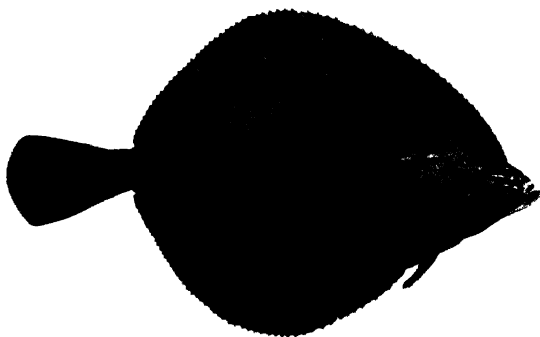
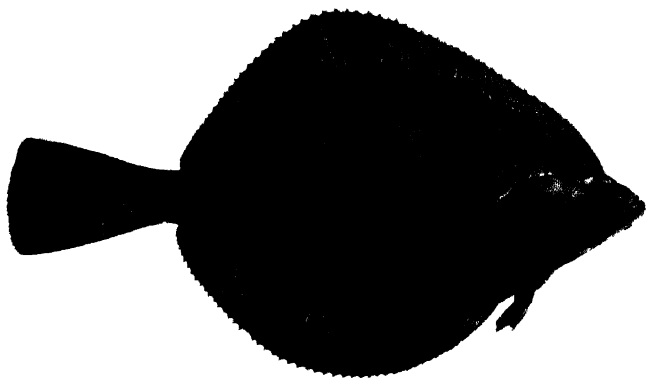
Pl. 64.

1. Greater Sand Eel. (p 161)

2. Lesser Sand Eel. (p 161)

3. Bearded Ophidium. (p 168)

N 170.



Pectoral fins very small. Body dotted on coloured side.

A line of black on every fifth ray in dorsal and ventral fins.

Solenette (*S. lutea*).

The fourth group includes seven British species belonging to the three genera *Rhombus*, *Arnoglossus* and *Zeugopterus*: Diamond-shaped body with blunt bony tubercles.

Turbot (*Rhombus maximus*).

Oval body covered with smooth scales. Brill (*Rhombus lævis*). Body narrow and thin. Scales rough. Eyes and mouth very large.

Megrim (*Arnoglossus megastoma*).

Scales and skin easily detached when captured. Eyes and mouth smaller.

Scaldfish (*Arnoglossus laterna*).

Dorsal fin commences before the eyes. Pectorals united with ventral.

Common Topknot (*Zeugopterus punctatus*).

Marginal fins continued beneath root of tail. Like the last, but first dorsal fin ray prolonged.

Bloch's Topknot (*Z. unimaculatus*).

Marginal fins continued beneath root of tail. A smaller fish with pectorals distinct from ventral and first dorsal fin ray not prolonged. Norwegian Topknot (*Z. norvegicus*).

The Plaice (*Pleuronectes platessa*).

The Plaice (Plate 65) is one of the best-known members of the Flat-fish family, as it is certainly the most important commercial species. The Plaice is such an important fish to the fishing industry of this country that it merits some detailed consideration. It is a somewhat sedentary species and therefore possibly susceptible to over-fishing, so that the study of its growth, habits, and life-history has been extensively pursued of late years. The Plaice may be recognised by the following characters: Eyes on the right side; mouth at the end of the snout; teeth most developed on the blind side; scales small and embedded in the skin; bony knobs on the

head between the eyes ; and red spots on the upper side of the body. The Plaice grows up to a length of about 33 inches ; the sizes met with in commercial fishing are referred to below. According to Holt, the female Plaice spawns in the North Sea at an average length of 17 inches ; in the English Channel, Cunningham found nearly all Plaice were mature at 15 inches.

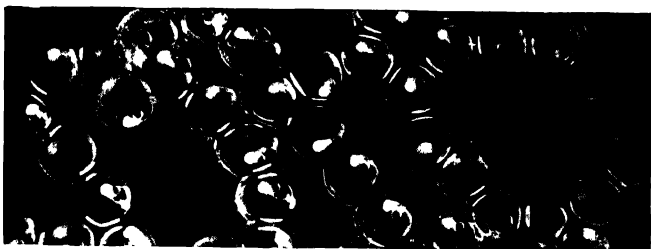
On the other hand, in Danish waters spawning female plaice have been taken at a length of only 7 inches. As a rule the male attains sexual maturity at a lesser size than the female, and in the North Sea ripe female plaice have been captured which were 9 inches in length. In the northern part of the North Sea, the average size at which the Plaice first becomes mature is for the female $15\frac{1}{2}$ inches and for the male 12 inches. According to Peterson, the average size in Danish waters is much less than this. Plaice first becomes mature in the Baltic at an average size of 10 inches, in the Lesser Belt at 11 inches, and in the Kattegat at from 12 to 13 inches. The adult Plaice differs in coloration from the immature fish ; in the former the red spots are surrounded by a white ring (Plate 65).

Probably the Plaice spawns annually after sexual maturity is attained, but there is no positive evidence of it. The spawning period of the Plaice has been very well determined for various parts of the North Sea. On the east coast of Scotland it extends from the end of December in some years, but more usually from the early part or middle of January to the early part or middle of May, the chief spawning taking place in March. The commencement and duration of the spawning season vary in northern European waters. In the Danish seas it begins in November, attains a maximum in January and February, and ends in April.

According to Buchanan-Wollaston, there are three separate spawning areas for plaice in the southern North Sea : off Flamborough, east of the Dogger, and the Flemish Bight.



Eggs of Salmon. (p. 219)

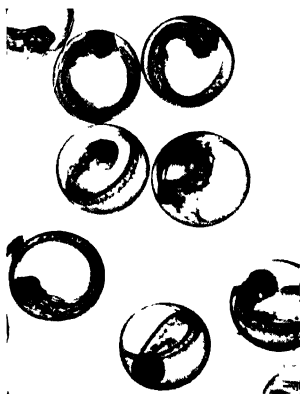


Eggs of Perch. (p. 33)



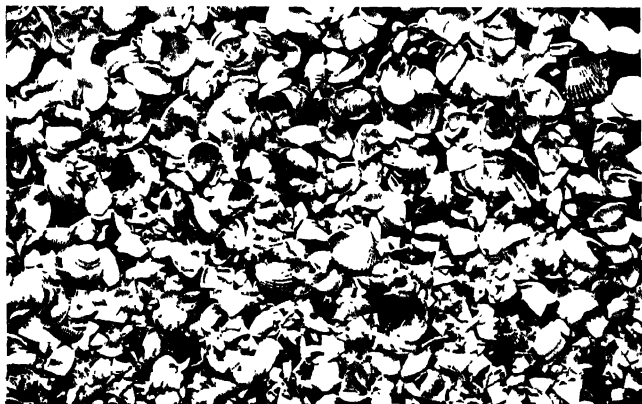
17 66

Eggs of Roach. (p. 196)



W 172

Eggs of Plaice. (p. 173)



Food of young Flounder.



Pl. 67

Food of young Plaice. (p. 170)

Pl. 173

Of these the last is much the most important, being supplied with fish from distant portions of the North Sea, as proved by the marking experiments. The centre of the Flemish Bight area lies to the eastward of the Gabbard and Galloper lightships. The area seems a well-defined one, the greatest number of pelagic eggs being found near the centres of highest salinity and temperature.

In Loch Fyne, in the Firth of Clyde, no plaice eggs were found in 1898 until the middle of February, and there was none left after June. In the Irish Sea, the writer has taken the eggs of the Plaice in mid-December in Cardigan Bay, but the main spawning season is in March. From a quarter to half a million eggs are produced by a female plaice, this being a considerably smaller number than that of some of its near relatives. The turbot produces on an average over $8\frac{1}{2}$ million, the flounder about a million, and the sole about 570,000 eggs. The eggs are naturally not extruded at once, the process of spawning being a gradual one. This is a physical necessity, since the female cannot hold all the eggs at the size they attain when mature, and they must ripen gradually and in succession.

It is evident that during the spawning season an immense number of fish eggs must be present in the seas round the spawning grounds, and efforts have been made to determine the numbers approximately. Williamson determined the number of plaice eggs in Loch Fyne in the spawning season of 1898 to be 483 millions.

The egg of the Plaice (Plate 66) is buoyant, and one of the largest of the Pleuronectids, being a little less than $\frac{1}{12}$ of an inch in diameter. It is enclosed in a fairly tough capsule, the outer surface being finely corrugated, and when extruded from the body of the adult female is transparent. Before ripening, the ovary of the Plaice contains opaque eggs considerably smaller than those subsequently extruded. In the final stage of maturation before spawning, these small opaque

eggs acquire the character of ripe pelagic eggs. Fluid of low specific gravity enters the egg, which as a result becomes almost transparent. The egg becomes larger and its specific gravity less. The immature ovarian egg is heavier than sea water, whereas the mature egg is very slightly lighter than sea water. Intra-ovarian changes of this nature are general in the maturation of the ovum of bony food fish, and as a result the eggs are pelagic and float near the surface of the sea when extruded. The duration of the spawning period in the case of the Plaice is not exactly known. According to Johnstone the Plaice takes about two weeks to extrude the whole contents of its ovary. Later experiments, conducted by Fulton, show that in the case of a plaice kept in confinement the extrusion of eggs was spread over four weeks. Fertilisation of the eggs takes place in the sea water into which the eggs are extruded. During the spawning season the males and females are crowded together on the spawning grounds, the extrusion of the sperms taking place at the same time as that of the ova.

It is difficult to estimate the number or proportion of eggs which escape fertilisation in natural conditions in the sea ; but probably the percentage is a very small one, since unfertilised eggs are extremely rarely found.

The period of development varies with the temperature, being longer at a lower temperature. Eggs fertilised in January at Dunbar hatched in from 16 to 18 days, while those hatched in April had a period of incubation of 8 or 9 days only. Dannevig found that at 5.2°C. , 21 days were required ; at 6°C. , $18\frac{1}{2}$ days ; at 10°C. , 12 days ; and at 12°C. , $10\frac{1}{2}$ days. Among the Pleuronectidæ there is a general correspondence between the size of the egg and the development period, other things being equal. The Flounder, with an egg of 0.095 millimetre in diameter, hatches in $4\frac{1}{2}$ days at 10°C. , while at the same temperature the Sole, which has an egg of 1.4 millimetres in diameter, requires 10 days, and the Plaice, with an egg of

1·8 millimetres, 12 days. For the technical details of embryonic development and the larval and post-larval changes, reference should be made to special works. Only the briefest summary is given here. When the young Plaice hatches out from the egg it is from 6 to 7·5 millimetres in total length, and at this stage the large yolk-sac attached to the ventral surface is a conspicuous object and the young fish is symmetrical, *i.e.* like a young cod or other round fish. For some time after hatching the young plaice continues to live on the food stored up in the yolk-sac. The larval period lasts from the time of hatching until the asymmetrical form of the adult has been attained, which is usually six weeks after hatching. During the first week there is little change except for the gradual disappearance of the yolk-sac, a process generally complete about the eighth day. The larva now takes external food, and is from now on absolutely dependent on it. Possibly this external feeding begins before the yolk has been entirely absorbed. The food of the plaice at this stage is necessarily of microscopic dimensions, consisting of diatoms and larval mollusca.

The young fish grows very slowly, and at the age of twenty-one days from the time of hatching is only about $\frac{3}{8}$ of an inch in length. After this the length increases relatively slower than the height. The young stages of various crustacea now form its principal food. The tail begins to be bent up at the tip, the fin-rays appearing on the lower or ventral surface. Up to thirty days after hatching the young plaice is symmetrical.

After the thirtieth day the left eye begins to move upwards and forwards; after forty days it appears on the upper margin of the head just in front of the right eye. On the forty-fifth day the left eye has attained its definite position above and in front of the right eye. During the period in which the eyes are rotating the young plaice gradually acquires a new position in swimming. At the completion of the metamorphosis the whole symmetry of the head has been profoundly disturbed,

though that of the body remains as before, with the exception of the opening of the ureter. The fish finally swims and rests on what is really its left side. The pigmentation now gradually disappears from this side. At this stage of their life-history the young plaice feed on small crustacea known as Copepoda, but larval molluscs and larval crustacea are also eaten. After metamorphosis is complete the food changes, and they feed on various worms (Annelids), and small bottom-living crustacea such as Amphipods, Mysis and small shrimps. Later the adult food is sought for, and this consists mostly of mollusca of the cockle and mussel family (Plate 67).

There are in general three methods of determining the rate of growth of Plaice. These are :

1. Determination of the size at different ages by means of observations of the rings of growth on the scales (Plates 11, 101).
2. Similar observations on the otoliths (ear-stones) (Plate 11). In England alone the determination of the age of many thousands of North Sea Plaice has been made by the otolith method.
3. To measure the whole of the fish caught in certain hauls where the fish are numerous, and to deduce the growth rate from the grouping of individuals of different lengths.

Another method is to keep the fish in aquaria and observe for as long a period as possible the increase of the body length. This method is open to serious objection, since the fish are living under artificial conditions; it is not relied on in determining the growth of sea fish.

Of the above methods the second and third have been extensively employed in the case of the Plaice and Dab (Plate 11), whilst the first method has been used for the Salmon, Herring, and other species.

According to Wallace, in the southern part of the North Sea, a plaice usually adds as much to its weight in the fourth year of its life as in the first three years combined. The

greatest average increase in weight probably occurs in the fifth and sixth years, but in the South Dogger region there is a marked diminution in the annual average weight-increment after the fifth year in the case of males ; the females, on the contrary, show no diminution in the sixth and very little, if any, in their seventh year. In the Southern Bight of the North Sea, the average length of the three-year-old plaice is approximately 21 centimetres for males and 22 for females (about $8\frac{1}{2}$ inches). In the great West Bay, the average length of plaice of the same age is 27 centimetres for males and 28 for females ($10\frac{3}{4}$ inches). The average annual growth is therefore about 7 centimetres in the first three years in the Southern Bight, and 9 to 9.5 centimetres in the western part. In the fourth year the average increase is 5.5 centimetres in the Southern Bight, and from 3.5 to 4 centimetres in the West Bay ; so that while plaice grow more rapidly at first in the West Bay, they grow less rapidly subsequently. In males, the advent of maturity is one or even two years earlier than in females.

The fact that sexual maturity is first attained by plaice of different sizes in different parts of the North Sea, is one reason why certain investigators have been led to put forward theories of distinct races of plaice. Several such theories have been suggested ; some have been modified by their authors as a result of further investigation. It is doubtful whether we possess sufficient information of the biology of the Plaice to justify confidence in the existence of " races " of plaice in the North Sea.

Probably the best method of determining the growth and age-groups in the case of the Plaice is by measuring large numbers of individuals caught together on the same ground. This method has been followed with success by Johnstone in the Irish Sea, about 16,000 plaice having been examined by him in the years 1909-13.

As a result of these investigations the modal lengths of

plaice in the inshore waters of the Irish Sea are given as follows :—

Plaice of age-group 0 (that is, over 0 and under 1 year old) are, on the average, $2\frac{3}{4}$ inches long.

Plaice of age-group I. (that is, over 1 and under 2 years old) are, on the average, about $5\frac{1}{4}$ inches long.

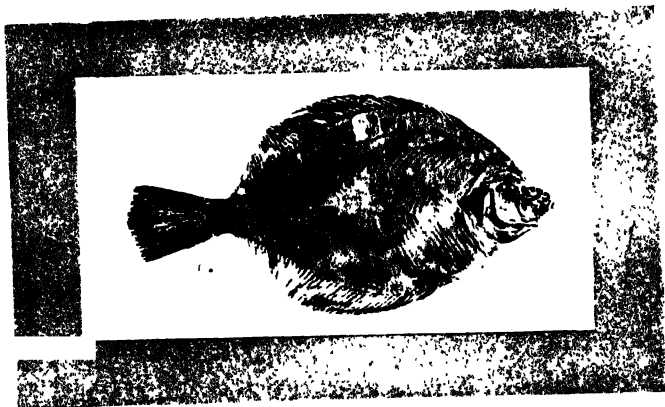
Plaice of age-group II. (that is, over 2 and under 3 years old) are, on the average, about $7\frac{3}{4}$ inches long.

Plaice of age-group III. (that is, over 3 and under 4 years old) are, on the average, $10\frac{1}{2}$ inches long.

Plaice of age-group IV. (that is, over 4 and under 5 years old) are, on the average, 13 inches long.

Large numbers of measurements of individual plaice have been made by the English, Scottish and German authorities, not only on the fishing boats but in the markets as well. Hundreds of thousands of measurements have been recorded and tabulated, and the higher mathematics utilised to clear up the vexed question of the destruction of immature fish.

To give one instance, the Germans have conducted since 1904 a series of "scientific market experiments," that is to say, they have measured and weighed large numbers of representative samples of sea fish landed at the markets by the commercial trawlers. Measurements were also made on board the trawlers of plaice and other fish so that a comparison might be made between the catches made on the trawlers and the fish landed at the markets. Roughly speaking, about $2\frac{1}{2}$ million kilograms of plaice were captured every year by German fishermen in the North Sea. This is equivalent to 2,460 tons. The number of plaice is estimated to be about 14 millions, and their length varies from $6\frac{1}{2}$ to 28 inches. The age of the individual fish ranges from two to twenty-five years, and the average weight is 6·3 oz. Of these plaice nearly one-half the total number—*i.e.* 7 millions—and nearly one-third the weight



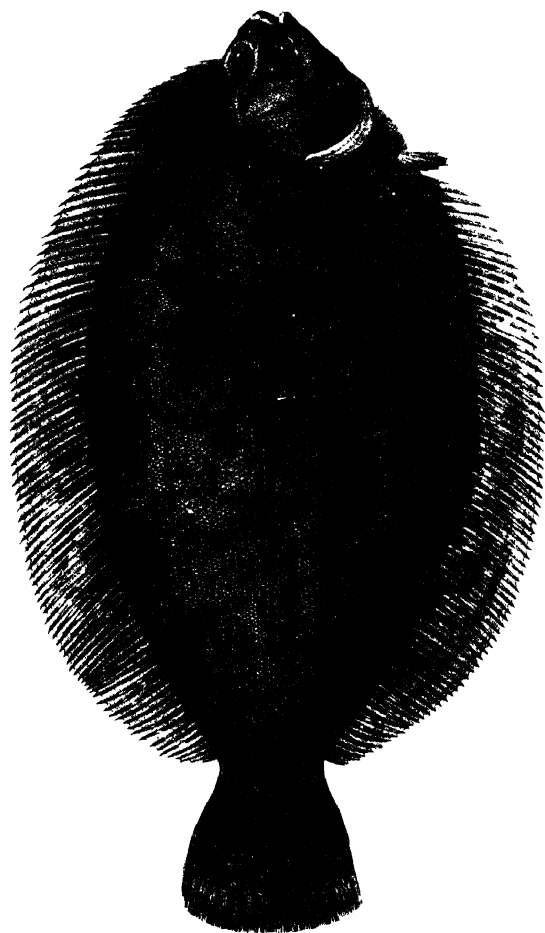
Marked Plaice. (p. 179)



Pl. 68.

Food of Mackerel. (p. 92).

V 178



Pl. 69.

Lemon Sole, (p. 152).

Pl. 179.

are so-called undersized fish. They are all under 10 inches in length, and under three and a half years old. Only 3 per cent. of the plaice caught by German fishermen are over 14 inches long and five years old. The German investigators assert that, in order to catch these 14 million fish for the markets, a very large number of still smaller plaice, from 4 to 8 inches long, are taken in the trawl-nets and hauled on to the trawler's decks. These small fish are not landed in the markets, since they are too small to be marketable, but they are probably either dead or dying before they are returned to the sea. At the very lowest calculation, not less than from 28 to 30 million young plaice are thus destroyed by German fishermen alone in the North Sea every year. These figures are sufficiently alarming even taken by themselves, but if the calculations are extended to include the plaice taken from the North Sea by English and Scottish fishermen, then the total amount of destruction becomes truly appalling. In 1913, no less than 237,183 cwt. of small plaice were landed in England and Wales, and of these 215,380 cwt. were landed on the East Coast. The "small" plaice landed by the English trawlers certainly number not less than 100 million individuals, and to catch these, in all probability, another 400 million undersized and unmarketable plaice are destroyed. The total quantity of flat-fish taken from the North Sea by all countries (except Norway) was estimated in 1905 to be 80,000 tons, and of this 67·2 per cent. was plaice.

During recent years the migratory habits of the Plaice have been traced by marking experiments. A large number of plaice have been marked and liberated in the North and Irish Seas. The label used consists of three parts, a bone button, an elliptical numbered brass disc, and a silver wire. It is attached to the fleshy part of the body, midway between the head and the tail (Plate 68). The marking operation only takes a few seconds, no blood is drawn, and the fish apparently

suffers no pain or inconvenience. The marked fish are kept for a time in tanks on board the investigating steamer, until they are seen to be thoroughly healthy.

The mortality among the marked fish before liberation is very small, certainly less than 1 per cent. The co-operation of the fishermen, which is essential to the success of the experiments, is secured by offering a small monetary reward for the return of a marked fish, together with particulars of the date and place of recapture. As a general rule the fishermen return the marked fish willingly, but in some cases they are reluctant to do so, fearing restrictive legislation as a result of the experiments. In the early days of the investigations the labels were frequently returned without the fish, and in one case the label bore unmistakable evidence of having been in the frying-pan !

These experiments have now gone on for many years, and definite migrations of plaice have been established in both the North and Irish Seas. Small plaice undertake comparatively short migrations, whereas plaice of large size often travel long distances in a short time. On the whole, plaice are sedentary fish. The Irish Sea must be regarded as comparable to a large lake with an indigenous plaice population ; it probably derives little by immigration from other waters. At the same time individual fish make remarkable journeys. Of a batch of fish marked and liberated off Blackpool two were recaptured off the east coast of Ireland—one in Courtown Bay, the other at the Layton coastguard station. These fish must have travelled at least 130 miles in six months. In the case of another batch of fish marked and liberated in Beaumaris Bay in October, one was recaptured by an Ostend steam-trawler, the *Jules Henri*, in 48 fathoms water near the coast of Waterford the following May, and another in the entrance to the English Channel by the Fleetwood steam-trawler *Eulalia* the following September. In one case a plaice was caught three

times in a few months. It was first caught, marked and liberated near Morecambe Bay Lightship. Ten weeks later it was again caught by one of the Lancashire Committee's cutters in Barrow Channel, and returned to the sea alive. Hardly a month elapsed before it was again caught, this time by a Fleetwood fisherman. The intensity of fishing in certain Lancashire inshore areas must be high. Many of the fish have been recaptured after two years. A plaice marked and liberated off Walney Island was caught over two years later, eight miles south-east of the Bahama Lightship, Ramsey Bay, Isle of Man. Another plaice, marked and liberated off Llanrhystyd, in Cardigan Bay, was found two years later only a few miles away at Llanon. In a third instance a plaice marked and liberated off Penkylan, in the County of Carnarvon, was recaptured, after two years, three miles west by north of the Barrels Lightship, Wexford. The record is held by a plaice which was marked and liberated in the North Sea in 1904 and recaptured in 1920. In the Irish Sea itself the percentage of recaptured fish is invariably high, *e.g.* in the Newcome Knoll (Mersey estuary) experiment in November, the percentage returned was 40; off Blackpool, also in November, percentage returned, 50; Morecambe Bay fish marked and liberated in March, percentage returned, 47. Many other instances could be given; on the whole, the percentage returned in the eastern portion of the Irish Sea is from 30 to 40. In Cardigan and Carnarvon Bays, a smaller percentage of the marked fish was recaptured.

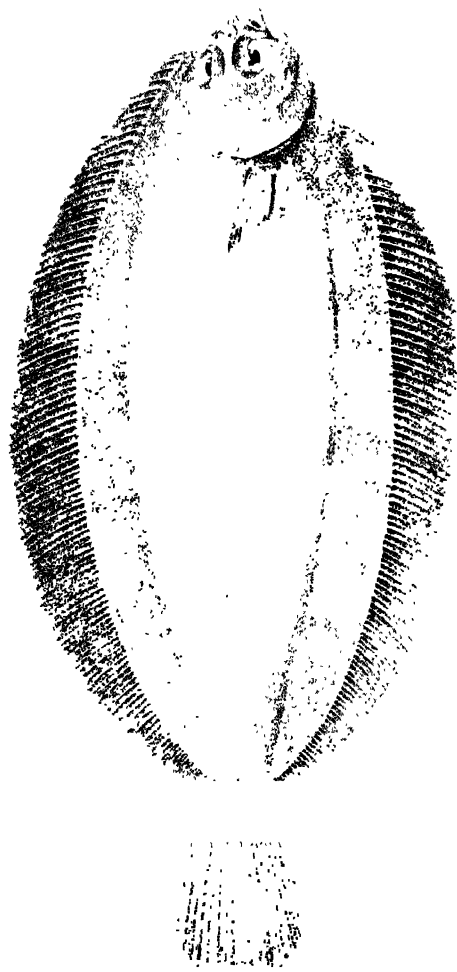
In the Irish Sea there is a broad distinction between summer and winter migrations, the former including those made from June to September, the latter from October to May. In the summer, the larger plaice move from the shallow waters inshore to the deeper and cooler waters offshore. The plaice fishery which is carried on by the Lancashire half-decked cutters from Nelson Buoy off the entrance to the Ribble, down

towards the Liverpool Bar and North-West lightships, is for fish which have moved out from the shallow waters of the channels and estuaries. The winter movements of plaice under 10 inches in length are mainly food migrations, or may be caused by the variations of the temperature in the coastal waters. These movements are alongshore, and follow no definite ascertainable order. The winter migrations of the larger fish are spawning migrations. The only large spawning ground for this species in the Irish Sea east of the Isle of Man is to the north-west of Douglas, where there is a regular winter fishery. The spawning plaice caught here by the trawlers have migrated outwards from Morecambe and Liverpool Bays, and to a less extent from the Solway, Luce Bay and the Firth of Clyde.

Since all the plaice are measured before liberation and after recapture, an indication of the rate of growth has been obtained. A striking result is that there is no growth in winter, that is, from October to March. Growth commences in April and is most marked in June, July and August. The average annual increase in length is 3 inches for fish which, when marked, were between 8 and 10 inches. The cessation of growth in winter is not due to spawning, since the majority of the fish marked were not spawners, but is due to the great scarcity of food in winter and a decrease of metabolism. The weight of a plaice of given length is always less in winter than in summer. Fish recaptured after two years had grown from $6\frac{1}{4}$ to $7\frac{1}{2}$ inches. Plaice, after carrying the labels for two years and more, were evidently none the worse, being plump and in good condition.

The Lemon Sole (*Pleuronectes microcephalus*).

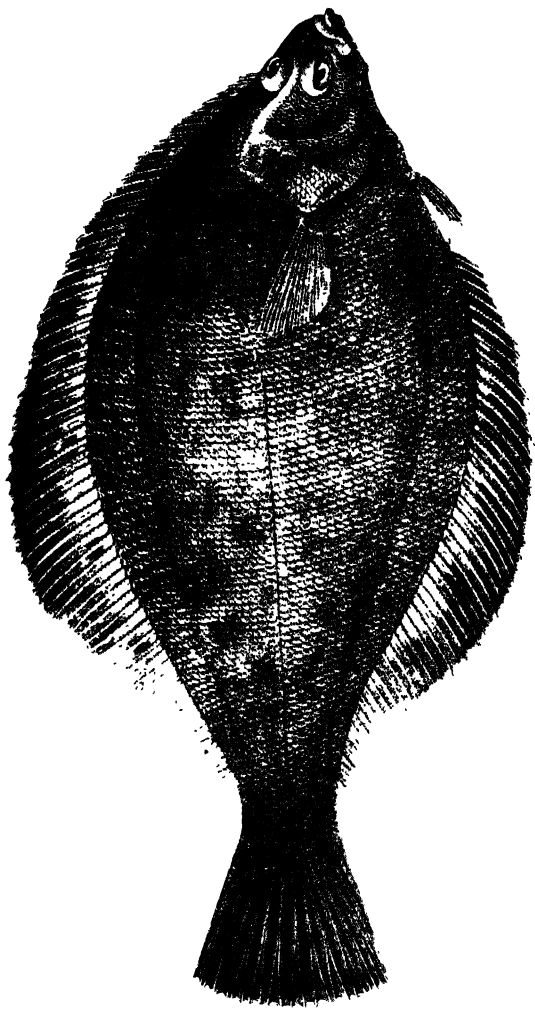
The Lemon Sole, or Lemon Dab (Plate 69), has a characteristic coloration and shape, which affords a ready means of distinguishing it from the other species of the genus *Pleuronectes*. The colour is a rich brownish-yellow, marbled with



P. 70.

Witch, (184).

N^o 182.



P 71.

Dab, up 150

W 153.

round and oval spots of darker or lighter colour; the shape is a regular oval. As the specific name indicates, the head is very small. The fish does not grow to a large size, 18 inches being the record.

It is a northern species, ranging from the Bay of Biscay to Iceland. The pre-war catch from the British Isles amounted to about 5,000 tons annually, and practically the whole of this was landed by steam trawlers. It is a dweller in water of medium depth, its favourite range being from 20 to 40 fathoms. Of the total catch, 32 per cent. comes from between the 30 and 40 fathom line, 31 per cent. between 10 and 20 fathoms, and 18 per cent. between 20 and 30 fathoms, and only 12 per cent. between 40 and 50 fathoms. In the Channel, the Lemon Sole spawns from February to July; in the North Sea, from April to September. The larvæ of Lemon Soles float longer at the surface than plaice, that is, they have a longer pelagic life. The adult fish ripen much earlier in southern waters. The egg is little more than $\frac{1}{10}$ of an inch in diameter, and 455,000 go to the quart. The egg is smaller than that of the Plaice, but larger than the Flounder or the Dab. At a temperature of from 53° to 55° F. the period of incubation is six days.

The larval Lemon Sole is hardier than the corresponding stages of other species of flat-fish, and McIntosh kept a number for six days in a small glass cell, the water being filled up as it evaporated. The fish begins to turn over on its side and live as a flat-fish when it is about an inch long; even the early hatched fish do not go to the bottom till late in the year, and they always go to the bottom in fairly deep water. The rate of growth of the Lemon Sole has been studied by observations on the scales, which show annual rings of growth. The fish is a slow grower. A 10-inch fish is, on the average, four years old. The smallest ripe female observed is 8 inches in length.

The Witch (*Pleuronectes cynoglossus*).

The Witch, or Pole Dab (Plate 70), may be recognised by the fact that the eyes are on the right side of the head; the lateral line is almost straight; by the absence of the spine before the anal fin and the presence of blister-like cavities beneath the skin on the lower side of the head. In the general body shape and appearance it is not unlike the true Sole, and in fact is frequently sold by unscrupulous shopkeepers as "White soles," or "Yarmouth soles," or simply "soles." The points enumerated above, and in particular the shape and size of the head and eyes (the eyes are much larger in the Witch than the Sole), will, however, afford a ready means of distinguishing these species.

The Witch is a species of the North Atlantic, and is common in certain localities around the British Isles. A typically deep-water fish, of muddy bottoms, it is rarely captured by the inshore trawler. Its habitat is beyond the 20-fathom line, and indeed in less depths than 50 fathoms it is by no means common. It has been reported from depths above 500 fathoms. Uncommon in the Channel, it is more abundant off our western coasts.

The Witch is not a large species. Specimens of from 15 to 17 inches are not uncommon, but records above 19 inches are very rare.

The Witch spawns from May to August, the chief time being July. The mature female produces from 500 to 800,000 eggs. The chief spawning grounds are to the west of Scotland and Ireland. The egg of the Witch, similar to that of the Flounder and Plaice, is 1·1 millimetres in diameter, the young larva hatching out on the sixth day at temperatures ranging from 53° to 68° F. The later larval stages and the metamorphosis from the round to the flat condition, are not so well known in the Witch as in other pleuronectids. It is

believed that the larvæ pass through their first winter in the pelagic condition.

The food of the Witch consists of marine worms, molluscs and echinoderms; more rarely fish is found in the Witch's stomach. About 1,200 tons of witches are landed annually in England and Wales, the total for 1923 being 25,234 cwts., valued at £42,891.

The Witch is comparatively rare in the inshore waters of the west of England and Wales. On the 26th June, 1905, I caught four specimens in the trawl from the Lancashire fisheries steamer, when fishing four miles south of Cilan Head in Carnarvonshire; and we have fairly numerous references for the Irish Sea since that date, but never more than a few specimens at any one time.

The Dab (*Pleuronectes limanda*).

The Dab, which is the smallest species of *Pleuronectes* (Plate 71), may most easily be recognised by the strong curve in the lateral line anteriorly, opposite the pectoral fin. The small size, brownish colour and scales which are rough to the feel, due to their spiny posterior edge, are also points to be relied upon in differentiating this species from its near relatives. The ridge behind the eye is smooth. In the live fish there are spots arranged somewhat similarly to those of the Plaice, but not so large or red.

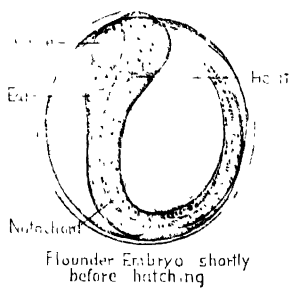
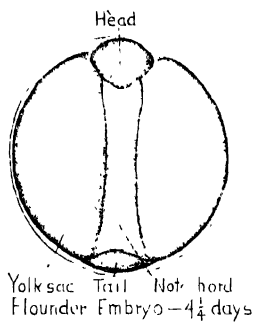
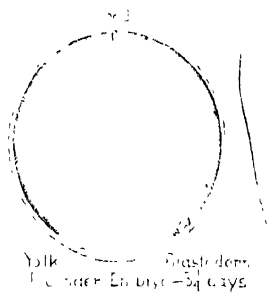
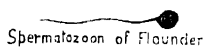
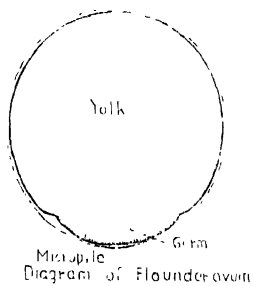
The Dab is widely distributed in the inshore waters of the British Isles, and is found in enormous numbers in our sandy shallow bays, where it competes with young plaice for the available food supply. It is a northern species, and is not found either in the Mediterranean or on the west side of the Atlantic. The Dab is abundant in the Baltic and on the Iceiandic coasts.

The extreme limit of size of the Dab is about 17 inches.

It becomes mature at a length of about $5\frac{1}{2}$ inches, the female producing from 80,000 to 129,000 eggs, according to her size. The spawning period falls in the months from March to May inclusive. In the Irish Sea the Dab spawns in shallow water, mostly between the 10 and 20 fathom line. The egg, like that of the Plaice and Sole, is pelagic, and is one of the smallest floating eggs of British flat-fish, being only 0·8 millimetre ($\frac{1}{125}$ of an inch) in diameter. The eggs have been artificially fertilised frequently and the young hatched out. The period of incubation varies greatly; in the early part of the season when the water is cold it may take as long as twelve days, but later in the year, in May or June, at a temperature of from 50° to 60° F., hatching takes place in three days. When first hatched the young of the Dab, like that of other flat-fish, is very small (2·6 millimetres long) and helpless, with no mouth or food canal, but with a yolk-sac attached to the abdomen. The young larva lives for about ten or eleven days on this yolk, and by that time the mouth, jaws and alimentary canal are developed. For a time the larva continues to lead a pelagic life, and during this pelagic life the metamorphosis from the round to the flat condition takes place. In the inshore waters of the sandy Lancashire and Cheshire bays, enormous numbers of the young recently metamorphosed dabs are taken close inshore along with similar stages of the plaice and flounder.

During the pelagic life the young Dab larva drifts inshore. When about an inch long it is found on the bottom, and by this time it has, of course, assumed fully the external appearance of the adult Dab. At this stage it is captured in countless thousands by shrimpers using the shrimp trawls from their half-decked boats, or by cart-shankers using a modified trawl-net (the shank) from their carts along the coast at low water, or by men and boys using hand or push nets under similar conditions. The period of the year at which these little dabs are met with in greatest numbers close inshore is September





and early October, and this is also true of the Plaice. But the Dab is found in greater abundance close inshore all the year round than is the Plaice. The Dab and Plaice form the mainstay of the inshore trawler's catches, at any rate on the west coast of England. The Dab is a more omnivorous species than the Plaice, eating, as it does, sand stars, small crabs, particularly hermit crabs, shellfish such as young cockles and mussels, and marine worms of various descriptions.

The flesh of the Dab is generally esteemed to be rather below that of the Plaice in flavour, but in the early spring the Dab, at any rate when eaten fresh at sea on board of a fishing boat, is a fish by no means to be despised. At other times of the year it must be admitted that the flesh of the Dab is rather soft and does not keep so well as the Plaice.

The Dab, or Garve, as it is sometimes called, is not to be despised from the fishermen's standpoint.

The Flounder (*Pleuronectes flesus*).

Owing to the opaque whiteness of its under surface, the Flounder is called the White Fluke by the Lancashire fishermen. This mother-of-pearl whiteness is characteristic, and serves as a ready means of distinguishing the Flounder from the other inshore species of *Pleuronectes*—the Dab, Plaice, and Lemon Sole. Curiously, the Welsh fishermen call the Flounder "Lleden ddu," literally the Black Flat-fish, the name in this case being derived from the dark colour of the upper surface (Plate 72). Incidentally, it should be noticed that it is not really the under surface, but the left side, which is colourless, and when the fish is lying on the bottom or swimming it is the right (coloured) side, on which both eyes are situated, that is uppermost. In another group of flat-fish, the Skates and Rays, the under surface is the ventral surface of the fish. The Flounder is flattened laterally, whereas in the

skate the compression of the body is vertical. Though not a species of great commercial importance, the Flounder is nevertheless, and particularly in the winter months, an important constituent of the hauls of the inshore fishermen along the Lancashire coast, where it is captured both by stake-netters and inshore trawlers. Unlike the other species of *Pleuronectidæ*, the White Fluke ascends rivers to considerable distances, and during an appreciable period of its life-history it exhibits a preference for brackish or even fresh water. In the Severn it has been recorded as far from the sea as Montgomeryshire, in the Dovey from Dinas Mawddwy, in the Conway above Trefriw, and in the Wyre from Garstang. Contrary to the Salmon, the Flounder's migration to the rivers is for the purpose of obtaining food, its seaward movement for spawning. The local fishermen say that the first frosts of the year drive the flounders out of the rivers ; at any rate, good catches are made in the estuaries following a frost. The fish are then heavy with spawn, which, however, is only discharged in deeper water.

In the Irish Sea, the Flounder probably spawns on the grounds in the vicinity of Morecambe Bay Lightship. In the Baltic and North Seas, owing to scientific fish-marking experiments, the spawning grounds are known with greater exactness ; in the former sea they are situated in a depression near the island of Bornholm, while in the North Sea the Elbe Flounder spawns in the south-west. From marking experiments, it has been proved that the Flounder travels at the rate of from 3 to 4 miles a day. One flounder is recorded as having travelled 40 miles in thirteen days, another 70 miles in eighteen days. A curious feature established by these experiments is that the Flounder, unlike the Salmon, does not as a rule confine itself to one river ; this is probably due to the fact that, while the river is the native place of the Salmon, in the case of the Flounder it is the sea. On its seaward migration from the rivers to the spawning grounds the Flounder takes no food, but

utilises the material stored up in its tissues for the development of the reproductive organs, so that when the spawning period is over there is a decrease in weight of one-fifth in the male to two-fifths in the female. Like all other flat-fish, the Flounder's egg is lighter than salt water, so that when the fish spawns the egg floats to the surface, where fertilisation takes place. The Flounder's egg is one of the smallest of pelagic fish eggs; the number carried by an adult female of average size is estimated to be about 970,000. This is a greater number than in any other Pleuronectid, and probably accounts for the fact that, in contradistinction to the other members of its family, the Flounder female is less abundant than the male. The spawning season is from February to May, and varies with the temperature; a cold season means later spawning. In the Baltic, it has been shown that the development of the Flounder eggs proceeds when the temperature of the surrounding water is below the freezing-point (0° C.), the actual temperature at which development commences being minus 1.6° C. The larvæ are hatched from the earlier eggs in eleven days, but later in the season, when the weather is warmer, six days are sufficient (Plate 73). The incubation period varies directly with the temperature. The egg itself is about 0.038 inch in diameter, and is hardly visible to the untrained eye.

In Morecambe Bay, the older fishermen believe that masses of eggs, the spawn of certain marine worms found on the shore, are the spawn of the Flounder. When the young flounder hatches out from the egg it is exactly like the larva of the cod in shape, *i.e.* round. During development it undergoes a metamorphosis until finally the adult shape is attained. The whole of the cranium in the region of the orbit rotates on its longitudinal axis to the right side, until both eyes come to lie on one side of the body. Flounders are peculiarly liable to the attacks of a sporozoan parasite, which produces round whitish swellings on the external surface of the fish. These

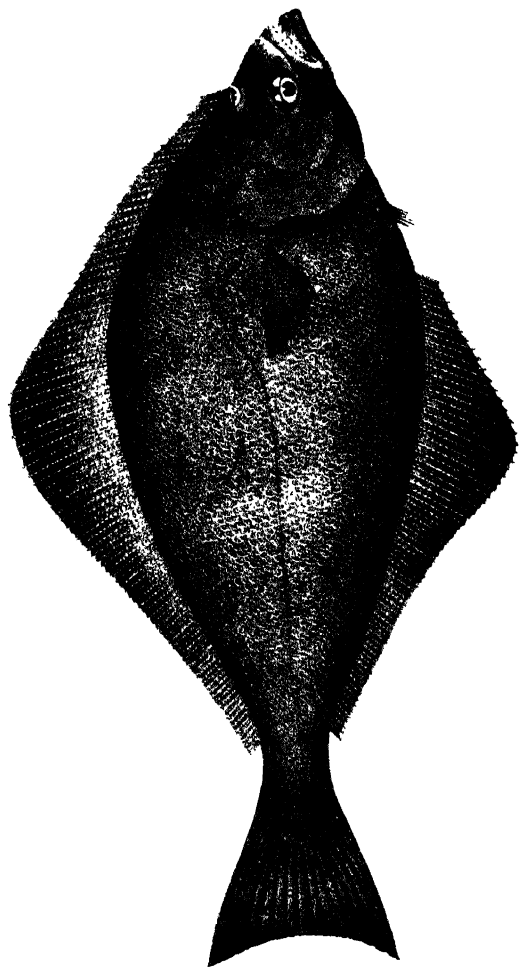
swellings have been regarded by some fishermen as the eggs of the fish adherent to the skin of the parent, and this is not so unreasonable as might appear at first sight, since scientific observers, after careful microscopic examination, have commented on the egg-like appearance of these tumours. Even if they are eggs they cannot possibly be the eggs of the Flounder, which are well known to be pelagic. Moreover, male flounders are attacked equally with females. The Flounder is sexually mature at a very small size; many males are ripe when 4½ inches long, and ripe females of 7 inches have been obtained.

The young flounder lives on cockles and other small shell-fish (Plate 67).

Flounders affected by the sporozoan parasite are not uncommon in Ulverston and Barrow channels. Individuals bearing wounds as the results of attacks by lampreys are to be met with in the estuaries of the Lune. Various other parasites are seen in and on the Flounder. A number of "fish-lice" are often found attached to the pectoral fin, in some cases twenty to thirty specimens on each fin. They are really parasitic crustacea, and have nothing in common with lice. Beyond causing a little temporary discomfort, the parasite does not appear to affect its host. Another species of crustacean attacks the gills, and in this case an actual malformation results. From a culinary standpoint, the value of the Flounder is not very high. Fishermen are contemptuous about it, and compare the taste to that of boiled wadding or boiled flannel.

The Halibut (*Hippoglossus vulgaris*).

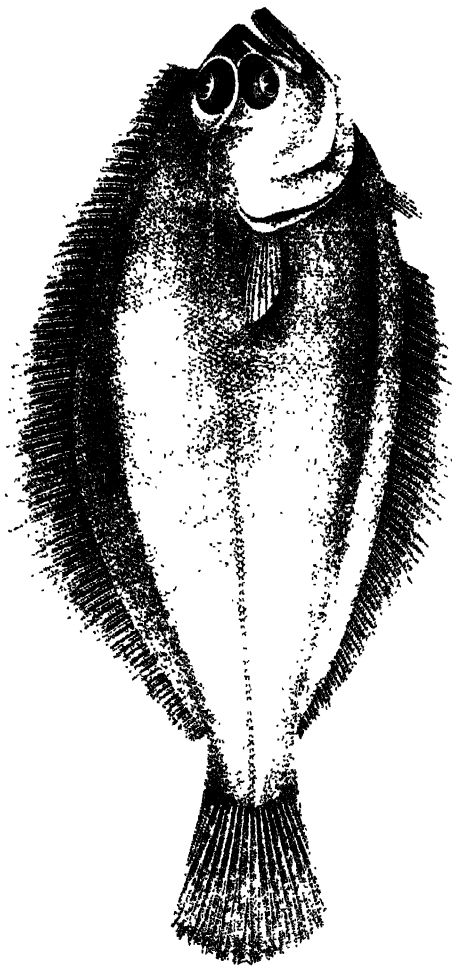
The Halibut is distinguished from all other British flat-fish by its great size, its thick and narrow body, its smooth scales and curved lateral line (Plate 74). The colour of the upper surface is dark olive, the lower surface is pearl white. A typically northern and deep-water fish, the Halibut is found both in the North Pacific and North Atlantic. In the North



Pl. 74.

Halibut. (p. 190).

N 190.



Atlantic it is common off Iceland and the Faroe Islands, to the north and west of Scotland, in the northern North Sea and off the Norwegian coast. It rarely enters the Irish Sea; personally I have never taken it in the trawl, but there are records from the Menai Straits and from the Isle of Man, where one was taken in 1829 measuring $7\frac{1}{2}$ feet and weighing 320 lbs.

The Halibut is gradually growing in esteem as a food fish in the British Isles. It is a fish caught both by trawl and line. So far as the British supply is concerned, by far the greater part comes from the Icelandic grounds, and the two chief British ports of landing are Grimsby and Hull, especially Grimsby. Halibut liver oil possesses valuable medicinal properties.

More Halibut are at present landed by deep-sea long lines than by steam trawlers. It is quite possible that large Halibut prefer rocky grounds where the trawl cannot operate. The chief spawning grounds of the Halibut lie to the north and west of the British Isles, the time of spawning being from May to July. The pelagic eggs are large, being about $\frac{1}{8}$ of an inch in diameter, 32,000 to the quart. More information is required as to the occurrence of the eggs and the young stages of the Halibut in the open sea adjacent to our coasts. Records of eggs or young larvæ are rare from British waters. Probably the surface drift of the larvæ is prolonged, since the spawning grounds are well offshore and young Halibut have been taken in depths from 4 to 25 fathoms. The rate of growth of the Halibut, based on study of the ear-stones or otoliths, has been established by Storrow, according to whom a Halibut 4 feet long would be twelve years old.

The Long Rough Dab (*Hippoglossoides limandoides*).

The Long Rough Dab (Plate 75) somewhat resembles the Halibut in shape, but is a much smaller species. It may be distinguished from the Halibut by its rough scales, which have spines on their posterior edges, and by the straight lateral line.

In the Halibut the scales are smooth and the lateral line has a curve. The Long Rough Dab is a North Atlantic species extending down to Cape Cod on the American side and to the English Channel on the east side. It is common in Icelandic waters, in the northern North Sea, off the Norwegian coasts and to the north and west of the British Isles. It rarely enters the Irish Sea, but has been recorded by White from the Menai Straits. In March, 1895, a specimen was taken in the "Hole" off Douglas, I.O.M., on the Lancashire Fishery steamer; and in December, 1908, a specimen was taken by a shrimp trawler in the Rock Channel, Mersey estuary.

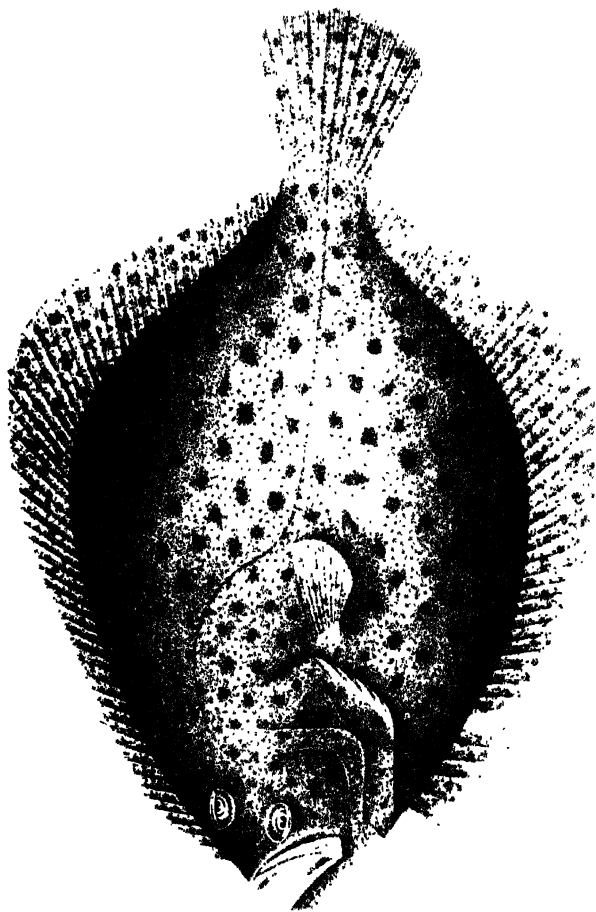
The Long Rough Dab spawns in the northern North Sea, off the Scottish coast and to the north and west of the British Isles in depths of 30 to 100 fathoms, at an average length of about 9 inches, so that it is a very much smaller species than its near relative, the Halibut. Ripe Long Rough Dabs have been recorded at 5 inches in length, the largest $16\frac{1}{2}$ inches, according to Cunningham. The spawning time is from February to May, but principally in March. The pelagic egg is one of the largest of our marketable marine fish, being just over $\frac{1}{12}$ of an inch in diameter. This egg is also distinguished by the remarkably wide space within the egg membrane. The incubation period depends on the temperature, lasting from five to fourteen days. The food of the Long Rough Dab consists of crustacea, echinoderms, fish, marine worms and molluscs, in order of choice.

The life-history of the Long Rough Dab is similar to that of the other Pleuronectidæ; the young undergoes a transformation from the round condition of its early pelagic life to the flat stage of later life, but it appears to seek the bottom in relatively deeper water than many other flat-fish.

SOLES (the genus *Solea*).

British soles differ from other flat-fish found in our waters in the fact that the margin of the head projects in front of the mouth, which is itself more distorted towards the blind side of the body; the jaws, which bear teeth on the blind side only, being strongly curved. On the blind side of the front part of the head there are tufts of filaments which, in large specimens of the Common Sole, are rather long and are called "whiskers" by our trawl fishermen. These filaments have a tactile function, and probably assist the Sole, which is a nocturnal species, in finding its food. The distribution of these filaments is constant in a given species and serves as a means of identification: see especially under the Solenette (p. 199). The scales in British soles are small, numerous and provided with spines at their free posterior margins. If the Sole be rubbed the "wrong way" this roughness is at once apparent. The body of the Sole is more flexible and elongate than in other flat-fish. There is only a very short gap between the dorsal, anal and caudal fins in British soles; in some exotic species which are captured by our trawlers off the coast of Morocco and occasionally exposed for sale in the London markets, the dorsal, caudal and anal fins are continuous. The dorsal fin commences far forward on the head, the pectoral fins are always small, and in one species, the Solenette, rudimentary on the blind side.

All our soles have the eye on the right side of the head. Specimens with the eyes on the left side must be extremely rare; the author has caught many thousands of soles in the trawl during the last twenty years, and no sinistral sole has come under his observation. The blind side is devoid of pigment, but instances of partial coloration on this side, particularly in the tail region, are not uncommon. In all our soles the egg is



recorded, and of these all but five were taken off the south-west of Ireland. One was taken in 150 fathoms by the *Flying Fox* in 1889, 47 miles west of the Bull Rock, Ireland; one by the *Research* in 1889, in 217 fathoms; and the remainder by the Irish investigation steamer *Helga* in 1904 and 1905, in 320 to 337 fathoms between 48 and 50 miles from Tearaght Light, Ireland. This is the same species as *Solea greeni* of Gunther's catalogue.

The Sole.

Although the Plaice is the most important flat-fish to the fish trade in the British Isles, the Sole is considered by many connoisseurs to be the best flavoured of all sea fish. The Sole is by far the most highly priced sea fish, and is still caught in large quantities by trawlers.

In its broad features the life-history of the Sole resembles that of the Plaice. There are, of course, several kinds of fish sold—some legitimately and some illegitimately—under the designation Sole. There are four species of Sole commonly met with in British waters, but of these the Solenette (*Solea lutea*) is too small to be marketable. It is, however, a common feature of the shrimpers' catch, where it is frequently mistaken for the young of the true Sole. Of the three edible species the Common Sole (*Solea vulgaris*) (Plate 76) predominates enormously. The writer has witnessed hundreds of hauls with the trawl, off the west coast, at varying depths and at all times of the year. In most of the hauls, made from all classes of fishing vessels, soles have been present, but only on few occasions, certainly less than half a dozen, was the French Sole or Sand Sole (*Solea lascaris*) met with; and the Thick-back or Variegated Sole (*Solea variegata*) twice only. These two species are probably more abundant on the other coasts, but they must constitute an insignificant portion of the British

catch of soles. The Sole is a southern species, and is not included in the fishery statistics of Scotland, Sweden or Norway.

Occasionally soles of the genera *Synaptura* and *Cynoglossus* are to be met with in British markets ; they are caught by steam trawlers on the grounds off the coasts of Portugal and Morocco.

Frequently soles are sold under local names ; for instance, at Chester as " Parkgate soles," or at Manchester as " Southport soles." These are generally true soles, even if not from the locality specified. Soles sold with any other qualification are almost certainly not the true Sole ; the " Lemon Sole " (*Pleuronectes microcephalus*) is a case in point. The Sole differs from the Plaice in its spawning habits. The former spawns in somewhat deeper water than the latter, and the spawning areas are more localised. In the Irish Sea there are three well-defined areas in which spawning soles are found in great numbers in the spawning season. Two of these areas have been heavily fished by steam trawlers in the spawning season for the last few years, and signs are not wanting that the third ground is also being exploited.

In the North Sea it appears to spawn in depths of about 22 fathoms (which corresponds closely with the Irish Sea sole) off the Dutch and Belgian coasts, from the middle of April to the end of June, May being the principal month.

The body of the Sole is much more flexible than that of the Plaice, and the Sole escapes easily through the meshes of a net which will retain a Plaice of equal size and weight. This body flexibility renders the marking of the Sole a difficult operation, and does not facilitate artificial hatching. In fact, the artificial hatching of the Sole, on even a moderate scale, has not hitherto been successful in the British Isles. To this the depth of water at which the Sole naturally spawns and the difficulty of obtaining milt from the males are also contributory

causes. The Sole is nocturnal in its habits, and is caught more frequently at night than by day; and in the daytime more frequently when the water is cloudy than when clear. It seeks its food more by sense of smell and touch than by sight, and, in the Irish Sea at any rate, prefers worms (*Nereids*) to any other form of diet.

The Sand Sole (*Solea lascaris*).

The Sand Sole, or French Sole (Plate 79), is very much like its near relative the Common Sole, but may be distinguished from it by the nostril on the blind side being nearly circular, very wide and surrounded by short-branched filaments. The body of the Sand Sole is also covered with numerous small black blotches and dots, which are not seen in the Common Sole.

The Sand Sole has a more southern distribution than the Common Sole, and it must be regarded as a rare fish in British waters, at any rate off the west coast. It ranges from the Mediterranean to south-west Britain, straying occasionally into the North and Irish Seas, where it is sometimes taken in the trawl in water from 5 to 10 fathoms deep.

The spawning habits of this sole are not known with any certainty, but it is supposed to spawn from May to July. I have taken this fish at times in Cardigan Bay, but some years have looked for it in vain, so it can only be regarded as an occasional summer migrant to Welsh waters. On the 22nd July, 1905, I caught a specimen 2 miles off Llanon (Cardiganshire); on the 30th August, 1905, two specimens in 6 to 7 fathoms of water in Barmouth Bay; on the 27th September, 1905, one specimen near the Patches Buoy off Aberystwyth; and on the 27th April, 1908, one specimen off New Quay Head, Cardiganshire. All these specimens were taken in the trawl.

The Thickback Sole (*Solea variegata*).

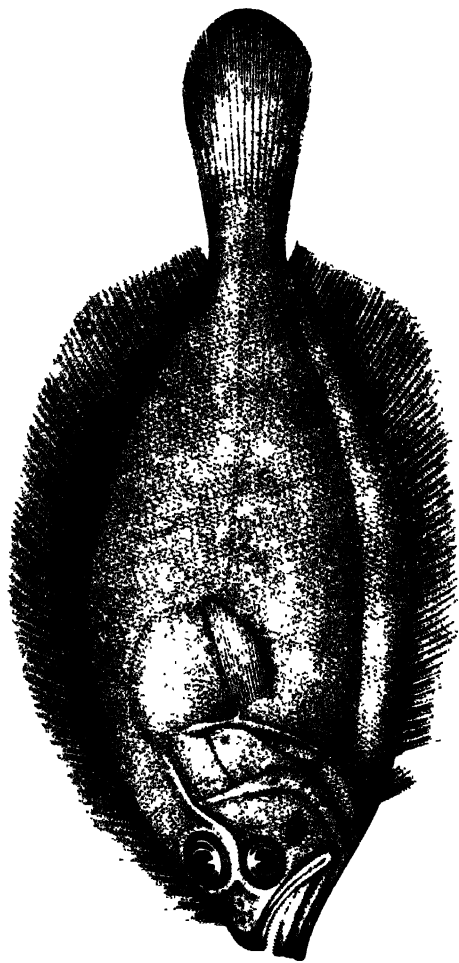
In the Thickback or Variegated Sole (Plate 80) the pectoral fins are very small. The colour is the most distinguishing feature of this species. It is brownish-red, with six or seven dark bands running across the body. The ends of these bands on the fins are black. The body is thicker than that of the Common Sole. The Thickback ranges from the Mediterranean to the British Isles, off the south-west coasts of which it is most frequently met with. It is a rare fish off our west coasts and in the Irish Sea, according to my experience even rarer than the Sand Sole. It is probably a deeper-water species than the latter. The Thickback spawns from April to May. The eggs are smaller than those of the Solenette, measuring only 1·3 millimetres in diameter.

The Thickback has been identified in the Irish Sea. Scott records three specimens taken 21 miles west-north-west from Morecambe Bay Lightship in April, 1894.

Personally I fished with the trawl for twenty years, at various places in the Irish Sea and neighbouring waters, before taking a specimen of the Thickback. In 1923, when trawling on the Lancashire Fishery steamer, a specimen was taken on the 9th May in Carnarvon Bay, 8 miles south-west by south from Llanddwyn Island Lighthouse, and on the 24th May three specimens were taken also in Carnarvon Bay, 7 miles south-west by west a half west from the same light.

The Solenette (*Solea lutca*).

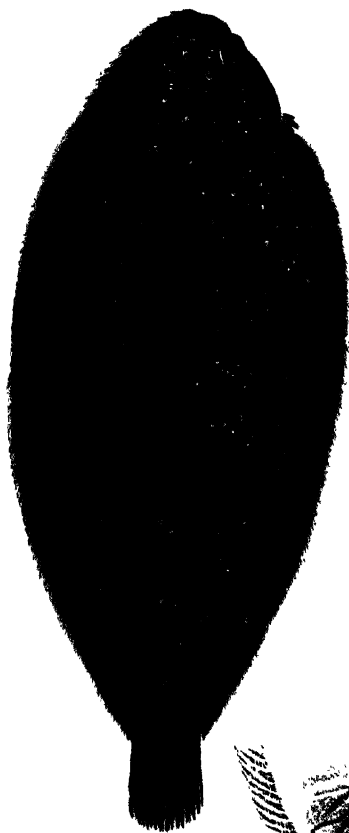
The Solenette (Plate 80) is the smallest of the British soles, rarely exceeding a length of from 4 to 5 inches, so that commercially speaking it is valueless. In the Solenette the pectoral and pelvic fins are very small. The Solenette is frequently taken by fishermen to be the young of the Common



P. 78.

Megrin. (p. 302).

O 108.



1. French or Sand Sole.

2. Under side of head, showing dilated nostril. } (p. 117).

Sole, but at regular intervals every fin ray in the dorsal and anal fins is black in colour in the Solenette. Usually every sixth or seventh fin ray is black. The general colour is darker in the Common Sole, more reddish-brown in the Solenette. On the under side of the snout in the Common Sole the villi, or little white tags, are closely crowded together and irregular in arrangement, while in the Solenette the villi form fringes round the edges of quadrangular depressions of the skin, and so give rise to a reticulate pattern. In the Sole the scales from the middle region of the body have from 10 to 16 radiating spines on their posterior border, while in the Solenette a scale from the same region has from 16 to 22 radiating spines. To determine this point satisfactorily recourse must be had to the low-power magnification of a microscope.

The Solenette ranges from the Mediterranean to the North of Scotland. It is common all round the coasts of the British Isles, and is especially numerous on the inshore shrimping grounds of the Lancashire coast. According to the fishermen the Sole and Solenette are not found together to any extent on the same grounds; the Sole prefers the seaward side of the sandbanks, whereas the Solenette is more abundant in the channels inside the banks. The Sole prefers a muddy, the Solenette a sandy, bottom. In spite of the fishermen's belief, and there is some truth in it, the Sole and Solenette are found together on the shrimping grounds at certain times of the year, the Sole being more abundant in autumn. Both species live on much the same kind of food—various crustacea, marine worms and shellfish. The Solenette becomes sexually mature at a length of $3\frac{1}{4}$ inches.

The spawning period is from April to August. The eggs are pelagic, with a single oil-globule, and measure, on the average, about 2 millimetres in diameter. Hatching takes place in from five to six days. The larva leads a pelagic life until it attains a length of $\frac{4}{10}$ of an inch, by which time the

metamorphosis from the round to the flat condition is complete, and the fish then sinks to the bottom.

The Turbot (*Rhombus maximus*).

The Turbot (Plate 77), in the writer's opinion the best flavoured of all fish, has the eyes on the left side. The mouth is large, situated at the end of the snout and provided with a band of villiform teeth, without canines, on both sides. The teeth and jaws are equal on both sides. The dorsal fin commences on the snout. The genus *Rhombus* comprises two British species, the Turbot (*R. maximus*) and the Brill (*R. lavis*).

The Turbot may be distinguished from the Brill by its diamond-shaped body and the presence of blunt bony tubercles or spines on the upper surface ; by the absence of scales.

The Turbot ranges from the Mediterranean to the Norwegian coast as far north as Bergen, and wanderers are even met with off the Lofoten Islands. It is not found on the American side of the Atlantic. In the British Isles it is a southern species, being rarely caught off the coasts of the Orkneys and Shetlands. Off the west coast and in the English Channel it forms an important constituent of the trawlers' catches.

A shallow-water species, the Turbot is only rarely taken in depths above 40 fathoms. Off the Welsh coast it is found frequently in depths from 3 to 10 fathoms, and indeed is often taken in seine nets fished on the beach at low water. It does not appear to ascend estuaries.

The king of sea fish, the Turbot attains a weight of from 25 to 32 lbs. Off the Welsh coast, it appears to mature at a length of about 17 inches in the case of the male, and 20 inches in the female. Its food consists principally of other fish, such as sand eels, sprats, dabs, soles and other denizens of shallow

water. The female produces from five to ten million eggs, and the Turbot is consequently one of the most prolific of our sea fish. The spawning period in the North Sea is from April to August; on the east coast of Scotland, from April to July. In Cardigan Bay and off the Welsh coast generally, the Turbot spawns between April and June. The eggs are pelagic, measuring 1·01 millimetres in diameter ($\frac{1}{25}$ of an inch), and are almost exactly the same size as the Flounder. The eggs can be distinguished from those of the Flounder by the single oil-globule (absent in the Flounder), which is of a pale yellow colour. The larva hatches out in from seven to nine days. When first hatched they are very small and helpless, being only from 2·2 to 2·8 millimetres long. In fact, the young Turbot is less advanced at hatching than any other Pleuronectid. There is an air-bladder in the young larva. The change from the symmetrical to the asymmetrical condition commences rather late in the Turbot larva, and young in a fairly advanced stage still have the eyes on opposite sides of the head.

Young Turbot, when they have completed their metamorphosis, are usually found in shallow water near the coast.

The Brill (*Rhombus lævis*).

The Brill (Plate 83), which is, like the Turbot, a highly esteemed fish, is narrower in proportion to its length, the general shape being oval. The body is also covered with small smooth (cycloid) scales. The upper surface is devoid of tubercles. It is somewhat smaller than the Turbot; the largest female Brill recorded by Fulton was 26 inches long, whereas the Turbot grows to a length of 3 feet.

The range of the Brill is very similar to that of the Turbot. It is found in the Mediterranean, in the North Sea up to

Bergen, in the Cattegat and in the Baltic as far as Mecklenburg. The Brill is common all round the British Isles, where it favours medium depths up to 30 or 40 fathoms on a muddy or sandy bottom.

Like the Turbot, the Brill lives on other fish almost exclusively.

The number of eggs produced by an adult female is about 825,000. Spawning takes place a little earlier than in the Turbot: in the North Sea, from March to August; on the east coast of Scotland, from April to June; and similarly off our western and south-western coasts.

The eggs are from 1·24 to 1·50 millimetres in diameter; they closely resemble the eggs of the gurnards. The life-history of the young brill closely resembles that of the Turbot, and the young post-larval fish are found close inshore in the shallow water of our west coast bays.

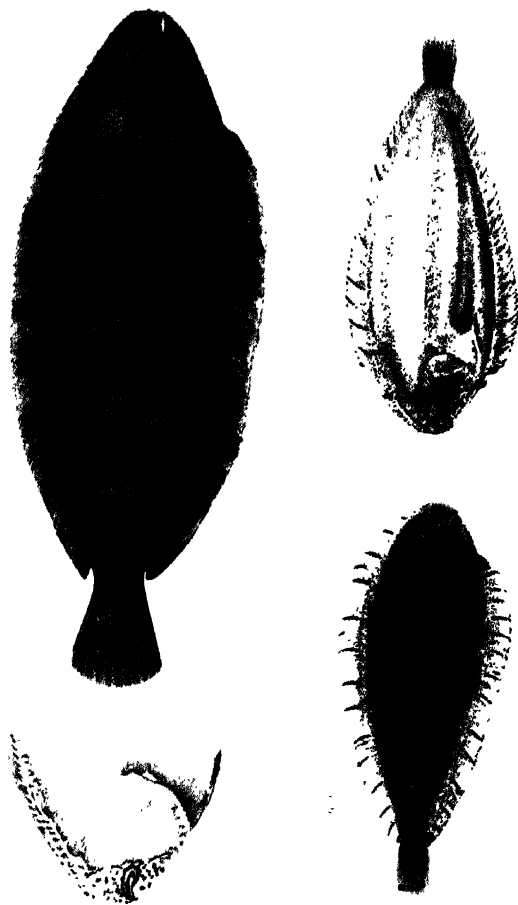
The Brill becomes mature in the case of the female at about 13 inches, in the male at 10 inches.

The Megrim (*Arnoglossus megastoma*).

The Megrim (*Arnoglossus megastoma*, Day, or *Lepidorhombus megastoma*, Coll.) is a deep-water flat-fish found all round the British coasts. In this species the eyes are on the left side (Plate 78), the mouth large, with teeth equally developed on both sides, small and in two rows. There are teeth present on the vomer.

The body is slender and thin, the head large with very large eyes. The scales are large and rough, provided with spines. The dorsal fin commences in front of the upper eye. In colour the Megrim is pale brownish-yellow.

The Megrim ranges from the Bay of Biscay to the Norwegian coast as far as Trondhjem, and is common off Iceland. In the east and south-east part of the North Sea it has not yet



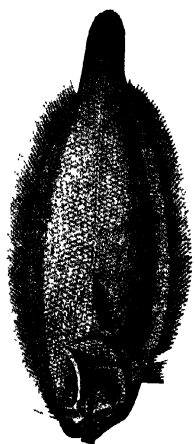
P. So.

1. Thickback or variegated Sole.
3. Solenette.

2. Under side of head with undilated nostril
4. Under side showing reticulate arrangement of villi on head.

() 202.

1887



Pl. 81.

Bloch's Topknot.
Scaldfish. (p. 203).

been found. Growing to a length of nearly 2 feet, the Megrim has a great bathymetrical range, having been taken in water from 4 to 220 fathoms deep, but on the whole it must be regarded as a deep-water fish. By no means common in the Irish Sea, it is nevertheless occasionally taken there in the trawl, but never in any quantity. Further to the south-west in deeper water it is much more abundant, especially beyond the 50-fathom line. Amongst flat-fish it does not rank high as a food fish, its flesh being rather dry. The Megrim is frequently sold as a sole, generally with some qualifying term, as "White Sole" or even as "Lemon Sole." Needless to say, it is much inferior in taste to the true Sole. The Megrim lives principally on other fish, such as sand eels, sprats and whiting. Crustacea and molluscs are only rarely eaten. Females are larger and more numerous than males, which is contrary to the general rule amongst fish. On the west of Ireland the proportion was found to be 372 females to 100 males. Here the fish spawns in March, April and May; on the east coast of Scotland the end of May seems the favourite time for spawning. The number of eggs produced by an adult female is about 440,000. The eggs are from 1·07 to 1·22 millimetres in diameter, with homogeneous yolk and a single clear oil-globule, closely resembling those of the turbot and brill. The development of the young inside the egg lasts from five to six days; the young fish when hatched is very small, being only 4 millimetres in length. The young larvæ of the Megrim are distinguished by the absence of coloured pigment (present in most other flat-fish larvæ), black specks being scattered equally over the head, body and fin membranes.

The Scald-fish (*Arnoglossus laterna*).

The Scald-fish (*Arnoglossus laterna*, Gthr., or *Platophrys laterna*, Walb.) is a small flat-fish fairly common on the British

coasts, but probably to a large extent overlooked on account of its small size and negligible market value. The eyes are on the left side (Plate 81) and are smaller than in the Megrim, as is the mouth. The scales are large and thin and very easily detached in the trawl net, so that the flesh is more or less bare when caught, as if it had been scalded. From this peculiarity it receives its name of Scald-fish. On the upper surface of the body the scales are spineless. The teeth are small and there is only one row. In the adult male the first ray of the dorsal fin is elongated. The Scald-fish, which grows to a length of 8 inches, ranges from the Mediterranean to the Norwegian coast, but its chief home appears to be in the North Sea. In the Irish Sea it is not uncommon, but owing to its small size no doubt it frequently escapes through the meshes of the trawl net. The Scald-fish is a summer spawner; in the North Sea it spawns from June till the end of August. The eggs are the smallest pelagic eggs known, the diameter being from 0.6 to 0.76 of a millimetre (about $\frac{1}{40}$ of an inch). The larva when hatched out is only 2.6 millimetres long. The absorption of the yolk in the yolk-sac takes place in a few days. Like many other flat-fish, the young larva of the Scald-fish is provided with an air-bladder which disappears in adult life. The male becomes mature at a length of $4\frac{1}{2}$ inches; the female at the same stage is slightly longer. According to Bowman, the post-larval stages of a closely allied species, *Arnoglossus imperialis*, Raf., were found in the northern North Sea off the Scottish coast in depths from 12 to 50 fathoms in September, October and November, 1904. This fish is really a warm-water species that wanders occasionally into the North Sea. Adults have been found at the western end of the English Channel at depths of from 30 to 40 fathoms, and again off the south and south-west coasts of Ireland. The post-larval stage has been discovered to the west of the Orkneys in September (Petersen). This fish attains a length of 8 inches.

Grohmann's Scald-fish (*Arnoglossus grohmanni*, Bonap.).

The first record of this species for the British Fauna was a specimen taken off Lundy Island in 1882, and described by Gunther in the *Proceedings of the Zoological Society*. *Arnoglossus grohmanni* is very similar to the Megrim (*A. laterna*), except that the body is brownish, clouded with darker colour, the fins with brown spots.

Since 1882 this species has been found to be fairly common off our coasts.

The eggs are small, from 0·72 to 0·74 millimetre in diameter. They are provided with an oil-globule. According to Holt the plankton larval stages of this fish attain a large size, much exceeding that of the closely allied Witch. Kyle says that *A. grohmanni*, Bonap., does not come into British waters, and that the British species is really a closely allied form, which Kyle describes under the name of *Arnoglossus thori*. In any case this fish is a small species, attaining a length of 15 centimetres.

The Common Topknot (*Zeugopterus punctatus*).

The Common Topknot (Plate 82) is a small Pleuronectid distinguished by its eyes being on the left side of the body, the mouth large, the scales very large, the dorsal and anal fins continued backwards beneath the root of the tail on the blind side of the body. The dorsal fin commences on the snout in front of the eyes. The scales are very spiny; the spines are long, projecting upwards from the surface of the skin, giving the body a rough hairy appearance. This species is called brownny or bastard brill by Cornish and Devonshire fishermen. It is the roughest of the three British Topknots, and has the anal fin united with the ventrals. This Topknot is the commonest and largest of the British species, but even so

is by no means often caught by our fishermen. It is, however, fairly frequently reported from the neighbourhood of Plymouth and in the estuary of the Clyde. It also occurs on the east coast of England and Ireland. The range of the Common Topknot is from the Bay of Biscay to Trondhjem, and is also found in the Cattegat and southward to the Sound. This species has the power of clinging to the surface of rocks. According to Cunningham, these fish adhere to the surface of the slate or glass sides of aquaria by a constant waving motion of the hinder part of the body, which pumps out water from beneath the body and so causes a pressure on the outside. They remain stationary thus for hours, and from their dark colour are difficult to distinguish on a dark surface.

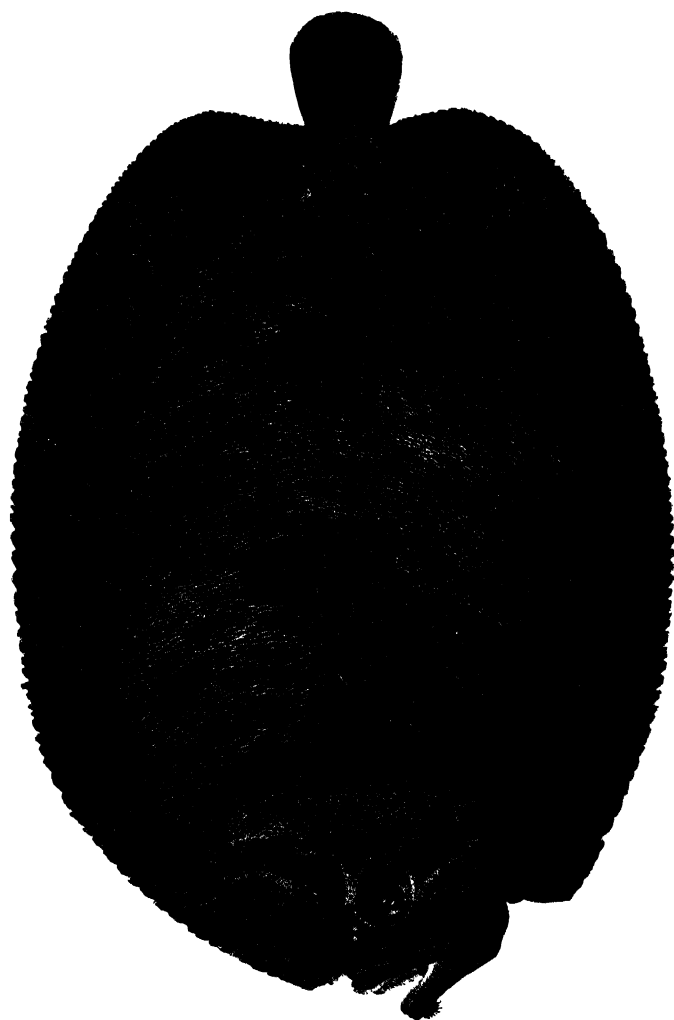
The Common Topknot spawns from April to June as a rule, but in the southern parts of the British Isles it may commence to spawn as early as March. The eggs have homogeneous yolk and a single oil-globule. They are from 1·00 to 1·07 millimetres in diameter, and are the largest of the Topknot eggs. The period of incubation is unknown, as are the youngest larvæ.

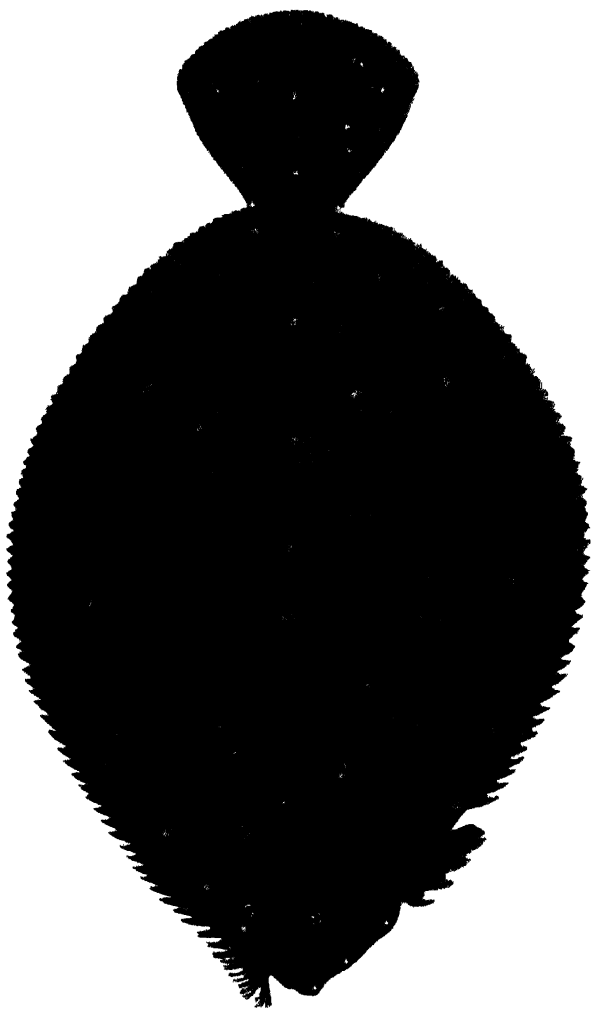
The Common Topknot has frequently been recorded in the Irish Sea, in the Menai Straits and off the Welsh coast.

Bloch's Topknot (*Zeugopterus unimaculatus*).

This species (also described as *Scophthalmus unimaculatus*, Risso) is distinguished by the prolongation of the first dorsal fin ray in the adult male (Plate 81). The lower side is rough, whereas in the other Topknots the lower side is smooth or only moderately rough. The anal fin is not united to the pelvics.

Bloch's Topknot is a more southern species than the others, ranging from the Mediterranean to the Shetlands.





It has now been found as far as Norway. The eggs of this species have been artificially fertilised by Holt. Like those of the other species they are pelagic eggs of small size, under a millimetre in diameter. There are several records for this species in the Irish Sea, but only one in Lancashire inshore waters. A specimen was taken by the Liverpool hopper *Beta* when trawling for specimens for the Liverpool Museum in the Mersey estuary in 1902.

Day gives nine British and Irish records for this fish. Since then a specimen 6 inches long has been caught in a shrimp trawl off Yarmouth (April, 1902, Patterson), and Holt records one $4\frac{1}{8}$ inches long, 4 miles south of Plymouth Mewstone in May, 1898.

The Norwegian Topknot (*Zeugopterus norvegicus*).

The Norwegian Topknot (*Zeugopterus norvegicus*, Coll., or *Scophthalmus norvegicus*, Gthr.) is the smallest of the British Topknots, and may be distinguished from the others by the body being less shortened and not so rough, the scales being less spiny and projecting. The first dorsal ray is not prolonged, neither are the pelvic and anal fins united. It ranges from the Lofoten Islands to Iceland, is found in the Cattegat, and has recently been recorded frequently on the British coasts. This species spawns in the North Sea from the middle of April to the middle of August. The eggs measure from 0.72 to 0.92 millimetre in diameter, and the young larva hatches out in about six days. Although there are no records of this species in the inshore waters of Lancashire, the eggs have been identified by Scott from among the plankton catches in Liverpool Bay.

THE PIPE-FISHES AND SEA HORSES (Syngnathidæ).

This family comprises a number of small fish of no economic importance, popularly known as Sea Horses and Pipe-fish. Marine fishes of coastal habit, the *Syngnathidæ* include a large number of species widely distributed in tropical and temperate regions. All these fish are feeble swimmers, and they are carried from place to place by currents. Some are found in brackish waters, and a few even stray into water which is quite fresh.

Six species are met with in British waters, and these may be distinguished as follows :—

Tail not prehensile.

Body with ridges.

Humeral bones movable, not united into a breast-ring. Broad-nosed Pipe-fish (*Siphonostoma typhle*).

Humeral bones firmly united into the breast-ring.

Great Pipe-fish (*Syngnathus acus*).

Body smooth, rounded, extremely long and slender.

Nerophis.

Caudal fin with 6 rays.

Snake Pipe-fish (*Nerophis æquoreus*).

No caudal fin.

Dorsal fin with 34 to 38 rays.

Straight-nosed Pipe-fish (*N. ophidion*).

Dorsal fin with 24 to 26 rays.

Worm Pipe-fish (*N. lumbriciformis*).

Tail prehensile.

The Sea Horse (*Hippocampus antiquorum*).

The Broad-nosed Pipe-fish (Plate 84) (*Siphonostoma typhle*) is a fish of the north-east Atlantic, ranging from northern Norway to Gibraltar. Growing to a length of 13

inches, it is not uncommon on British coasts. The spawning period is in May and June, the adult fish migrating from inshore waters to a depth of 2 fathoms and above for this purpose. In this family of fish the young are reared in a marsupial pouch or fold of the skin of the male. Even after they escape from this pouch the young fish remain for protection in the vicinity of the parent, occasionally re-entering the pouch for shelter. In this species the young escape from the brood pouch by the end of July, when they have assumed the adult appearance.

The great Pipe-fish or Needle-fish (Plate 84) (*Syngnathus acus*) ranges from Trondhjem to the English Channel. In the Irish Sea it is commonly taken in shrimp trawls off the Lancashire coast, where it is known as the Horn-eel. Spawning takes place in spring and summer, the eggs being received into the pouch of the male as in the preceding species. The young lead a floating or pelagic existence, and specimens have been captured at the surface off Plymouth in July. The newly hatched larva has the typical appearance of the adult.

The genus *Nerophis* is found in the Atlantic Ocean. The largest member of the genus is the Snake Pipe-fish (Plate 84) (*N. æquoreus*), which is distinguished from the other species by the caudal fin. This fin may be absent from the largest specimens, which are, however, distinguished by their size. The Snake Pipe-fish has been found from the Mediterranean to Tromsø, and also on the American side of the Atlantic. Spawning takes place in June and July. The eggs become attached to the glandular surface of the abdomen of the male. The young larvæ are hatched out in a relatively earlier stage of development than in the preceding species.

The straight-nosed Pipe-fish (Plate 84) (*N. ophidion*) ranges from Trondhjem to the Mediterranean. This species is rarely recorded in British waters, as, owing to its small size

and lack of value as food, it is frequently overlooked. Day gives about eight references for British and four for Irish waters. More recently it has been recorded in *Zostera* beds at Ballynakill and Blacksod (Farran). Little is known of its habits, but it is said to live between tide marks hiding under stones. Probably it migrates offshore about the end of May in order to spawn. The deep-yellow eggs are a millimetre in diameter.

The smallest of the Pipe-fishes, the Worm Pipe-fish (Plate 84), extends from the coast of France to Trondhjem, but is commonest off the west coast of Britain. Spawning takes place in June and July.

In the Pipe-fishes the marsupial pouch is formed in the male by a fold of the skin arising on each side of the trunk and tail; the free margins of these folds become united in the middle line, forming a pouch in which the eggs are hatched, having previously been deposited there by the female.

The last British member of this family is the Sea Horse (*Hippocampus antiquorum*), a fish of very peculiar appearance (Plate 84). This fish swims with the body in a vertical position; the prehensile tail can be turned about, so that the fish can anchor itself. The marsupial pouch is developed at maturity and then persists on the ventral side of the abdomen behind the anal fin. The young when hatched have the characteristic appearance of the adult, with the prehensile tail already developed.

BALISTIDÆ.

The File-fish (*Balistes caprisus*).

The File-fishes are distinguished by a compressed body which is either rough or covered with movable scutes. The first dorsal consists of a few spines only, the first of which is



Pl. 54.

P. 210.

- 1, 2. Greater Pipefish and young.
3. Snake Pipefish.
4. Broad-nosed Pipefish.
5. Straight-nosed Pipefish.
6. Worm Pipefish.
7. Sea Horse.

(p. 209).



very strong, file-like and hollowed out behind to receive the second, which is much smaller and has a projection at its base in front fitting into a notch in the first. These two spines can only be moved simultaneously; the first cannot be forced down unless the second has been already depressed. From this peculiar arrangement the name "Trigger-fish" has been given to this species (Plate 86).

File-fish are tropical forms inhabiting rocky or coral grounds. They are mostly found near the coasts of tropical seas, but as they are very feeble swimmers they often drift out to sea and are then carried considerable distances by tides and currents. Day gives two species for the British coasts, but the occurrence of *Balistes maculatus* is very doubtful, and it should not be admitted to the British Fauna without further evidence. There are two records of *B. capriscus* in Irish waters, one in Galway Bay in 1853; the second in Courtmacskerry Bay, County Cork, in 1909. This specimen, which is 9 inches long, is now in the Irish National Museum (Scharff). There is also a record for Brighton in 1901 (Toms) and Caermarthen Bay (1932). This last specimen is in the Tenby Museum.

TETRODONTIDÆ.

The Globe-fish (*Tetrodon lagocephalus*).

The original family of Gymnodontes, as the result of modern research, has been subdivided into several families. Of these the Tetrodontidæ are represented in British waters by one species, the Globe-fish. The Globe-fishes are inhabitants of tropical and sub-tropical seas. In this fish the body is shortened. The Globe-fishes have the power of distending the œsophagus with air, and so inflating the body like a balloon. The skin is covered wholly or partly with spines, which, when

the body is blown out to the shape of a ball, protrude and so form a defensive armour. Hence these fish are sometimes called "Sea Hedgehogs." In the British species these spines are only present on the under surface of the throat and abdomen, otherwise the body is unprotected. The Globe-fish is a feeble swimmer, but is occasionally drifted into our southern waters by warm ocean currents coming from the tropical Atlantic. Day gives about a dozen authentic records from British, and four from Irish, waters.

ORTHAGORISCIDÆ (MOLIDÆ).

The Sun-fishes (*Orthogoriscus mola* and *O. truncatus*).

The Sun-fishes, which were formerly included in the family of Gymnodontes, are now usually placed in a distinct family, the Orthagoriscidæ or Molidæ. They are pelagic, surface-living fish of wide distribution in temperate and tropical seas, and their body is of extremely peculiar appearance, being particularly well adapted for a passive drift in ocean currents. The body is compressed and very short, and the fish looks as if the original tail end had been chopped off and a new extremity grown, since the tail is extremely short and truncate. The vertical fins are confluent. There are no pelvics and no air-bladder. The jaws are without any median suture, feeble, covered to the margin with a band of enamel, and well adapted for masticating the small floating crustacea which constitute their food-supply. In the Sun-fish proper (*O. mola*) the skin is rough; in the oblong Sun-fish it is smooth and tessellated.

The Common Sun-fish (Plate 85) grows to a very large size; specimens measuring 7 or 8 feet and weighing 7 or 8 cwts. have been recorded. In British waters it has been taken from the Orkneys to the coast of Cornwall, and references

to its capture are fairly numerous. It appears to drift into our waters from the North Atlantic by the agency of the Florida Current (so-called Gulf Stream) nearly every year, and individuals are seen and occasionally captured in the Channel nearly every summer between the months of June and September, sometimes even in October or December. On one occasion a specimen drifted some miles up the River Exe before it was captured. Amongst the largest recorded by Day was one taken off Connemara weighing 6 cwt. 42 lbs., and another taken in August, 1870, off Swanage measured 6 feet 10 inches long and 4 feet 5 inches high. It is so abundant off the Irish coast that the Aran Islanders are said to have carried on a regular fishery for it by means of a harpoon, but apparently there has been no fishery of this kind for many years now. Every summer many specimens may be seen basking in calm fine weather at the surface of the sea off the west coasts of Ireland. In October, 1902, a Sun-fish 5 feet long was found dead on the shore on Goose Island, off which island they are not uncommon; and one weighing 2 cwt. was taken in Larne Harbour in September, 1917 (Scharff). One was taken off North Shields in December, 1923 (Storow).

The Truncated Sun-fish (*O. truncatus*) is much rarer. Day gives about ten authentic records of its occurrence in British waters. Up to 1906 there were three Irish records: one from near Youghal in 1837, one from Waterford in 1845, and one from Tralee Bay in July, 1906 (Scharff). This last specimen, which was of a beautiful violet colour above and almost white underneath, measured 2 feet 2½ inches in length and weighed 18½ lbs. It is now in the Irish National Museum. Since then a truncated Sun-fish 2 feet 6 inches long was obtained at Baltimore (Ireland) in May, 1915, and identified at the British Museum.

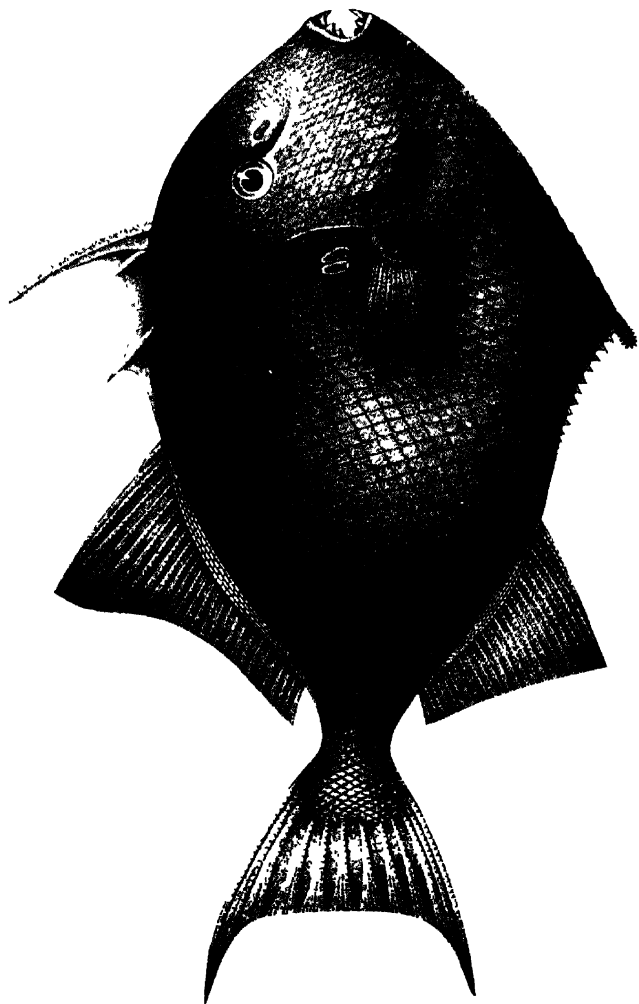
The spawning times and eggs of these fish are not known. The young larval stage is, however, well known, and as it

differs so much in appearance from the parent it was at one time considered to be a separate species and described as such under the name of *Ostracion boops*. A later stage in the growth of the larva shows a greater similarity to the adult form, but even so the young fish is provided with a number of long spines on the body, and was described as a separate species under the name of *Molacanthus*.

THE SCOPELIDÆ.

The Scopelidæ are small pelagic and deep-sea fishes. They comprise species which were formerly included by Gunther in two distinct families, the Scopelidæ and Sternoptychidæ. Of these at least three distinct species have been washed up on our shores or caught in the immediate neighbourhood thereof.

In the genus *Scopelus* the body is oblong, more or less compressed and covered with small scales. The most characteristic feature is the series of phosphorescent spots which run along the lower side of the body, and similar spots are found on the front of the snout and the back of the tail. At least thirty species have been described, one of which, *Maurolicus pennantii*, has been taken in British waters. Day gives quite a number of references to its occurrence. Sim collected in two winters at least two hundred examples on the beach at Aberdeen, where it is cast up in great abundance during the months of January, February and March. A specimen $1\frac{1}{2}$ inches long and $\frac{3}{8}$ inch deep, with chocolate-coloured back and extremely elongated lower jaw was taken on Gorleston Beach in 1889 (Patterson) and identified by Southwell and Day. Three others were taken on the north beach at Yarmouth in February, 1890, and another at the north beach, Scratby, in March, 1893. In March, 1924, one was picked up on the beach at Beadnell Sands (Storow). Larvæ of a closely allied species (*Scopelus glacialis*, Reinh.;





N. 87.

Small spring Salmon from the Wye. (p. 223).

P 215.

Myctophum glaciale, Reinh.) have been taken in June, 1905, north-west of the Shetlands.

Another fish belonging to this family, *Argyroleucus hemigymnus*, Cocco, was described and figured by Day from a specimen "stated to have been dredged in 540 fathoms between the Shetlands and the Faroe Islands." Holt and Byrne obtained a larva of this form in 150 fathoms from the west of Ireland.

Another species (*Paralepis coregonides*) was caught by Dunn at Mevagissey in 1869 and is now in the British Museum. The members of this family are, however, of little general interest and need not be considered further here.

A complete list of new British records will be found in the Appendix (pp. 351-375).

SALMONIDÆ.

The Salmon (*Salmo salar*).

The members of the Salmon family are typically anadromous fish found in the temperate and arctic regions of the Northern Hemisphere. According to Tate Regan, they may be regarded as marine fishes which are establishing themselves in fresh water; there are many permanently fluviatile or lacustrine forms, but others spend a considerable portion of their life in the sea, and in some instances migratory and non-migratory fish are to be found within the limits of the same species. On the other hand, some authorities regard the Salmon (Plate 90) as a fresh-water fish which has acquired the habit of going to the sea for its food, returning to its original home to spawn. The general rule among fishes is, however, that where a species inhabits both fresh and salt water at different stages of its life-history, it is a marine fish which takes to fresh water and not the reverse; for instance, the Bass, Shad and Herring are

members of families of marine fish which reside temporarily in fresh water. The distribution of the Salmon is also in favour of the theory that it is in origin a marine species. It is an Atlantic and not a European species, being found on the eastern side of the Atlantic in all suitable rivers in Britain and on the Continent of Europe from the White Sea to the north of Spain, including the Baltic and Iceland. On the western or American side it is found on the coast and in rivers from Cape Cod to Ungava Bay, and is landlocked in lakes in Maine and New Brunswick. In the Pacific the true Salmon (*S. salar*) is not met with, but there are a number of species of "Salmon" belonging to the genus *Onchorynchus*, five of which are of considerable economic importance and form the basis of a large canning industry, the headquarters of which are now in Alaska. These five species are the Humpback or Pink Salmon (*O. gorbuscha*), which attains a length of 2 feet and a weight of 6 lbs. ; the Dog Salmon (*O. Keta*), which grows to a length of nearly 3 feet and attains a weight of from 12 to 16 lbs. ; the Chinook, Quinnot or King Salmon (*O. tshawytscha*), the most valuable species, attaining a length of 4 to 5 feet and a weight of 22 to 100 lbs. ; the Silver Salmon or Coho (*O. kisutch*), growing to a length of 2½ feet and a weight of 10 lbs. ; and the Sockeye, Blueback or Red Salmon (*O. nerka*), which reaches a length of 2½ feet and a weight of 10 to 11 lbs.

A point of considerable interest is that these Pacific Salmon only enter the rivers to spawn, the whole life being spent practically in the sea, where the fish are gregarious and are sometimes caught in large numbers in the bays and sounds around the Aleutian Islands.

Except where there is serious pollution, either from lead-mines as in the Ystwyth and Rheidol, or from sewage and trade effluents as in the Mersey and Thames, Salmon are found in all the larger rivers of the British Isles. It is not always easy for an amateur or for an inexperienced fisherman to distinguish a

Salmon from a Trout, but the following points may be relied on. The dorsal fin has more branched rays in the Salmon (10 to 12, exceptionally 9) than in the Trout (8 to 10, exceptionally 11). The scales on the tail are larger in the Salmon, there being from 10 to 13 in an oblique series from the base of the adipose fin downwards and forwards to the lateral line, whereas in a similar position in the Trout the scales are smaller and there are 13 to 16.

In the Salmon the tail is more constricted at the base of the caudal fin than in the Trout, so that a Salmon does not usually slip through the fingers when grasped around the root of the tail, as does the Trout. In the Salmon the caudal fin is emarginate, that is, slightly forked, and is almost always more distinctly notched than in a Trout of the same size. In an adult Salmon the anal fin is less pointed than in a Trout, so that when it is laid back the last ray usually extends farther than the longest, the reverse being true in the Trout.

Atlantic Salmon are more closely related to Atlantic Trout than are Atlantic Salmon to Pacific Salmon, so that the Trouts (both river and sea Trouts, which the best authorities, such as Tate Regan, now regard as being one and the same species) have evolved from the Salmon taking more and more to a fresh-water mode of life. The Salmon therefore are to be regarded as living in the open sea, where in fact they feed on herring, sand eels and mackerel. They enter fresh water for the purpose of spawning, and this usually takes place from September to February. Salmon will, however, enter rivers and run up at almost any time of the year. They are usually divided into two main groups: those that run in the early months January to May, the spring fish; and those that return to the rivers from the sea in late summer and autumn and are known as summer or autumn fish. Throughout the year they approach the coasts and enter the rivers, in the estuary generally ascending with the tide. They display great perseverance

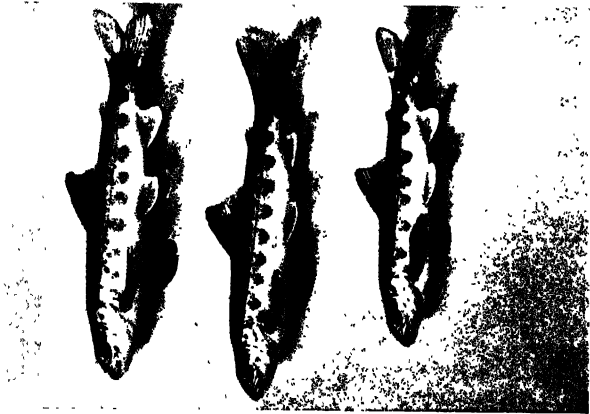
in travelling upstream, swimming up rapids and leaping falls of moderate height, up to a limit of about 10 feet.

In the larger rivers there are regular runs of clean Salmon in the winter and early spring, and it seems established that in the Scottish rivers, provided the obstacles are not too great and there is a sufficiency of water, the Salmon makes a fairly rapid journey to the headwaters of the river, where it stays without feeding until the following autumn, when it spawns. There is no regular feeding on the part of the Salmon in fresh water. On arrival at the spawning grounds, they segregate themselves into pairs and seek a suitable gravelly bed in shallow water of from 2 to 3 feet in depth.

In the Wye, a river 150 miles long, Salmon spawn within 4 miles of the source just below the slopes of Plynllymmon. They will run up every small tributary, and have been seen in the little Cynfiad brook which is barely a yard wide, and in places where there is barely enough water to cover their backs.

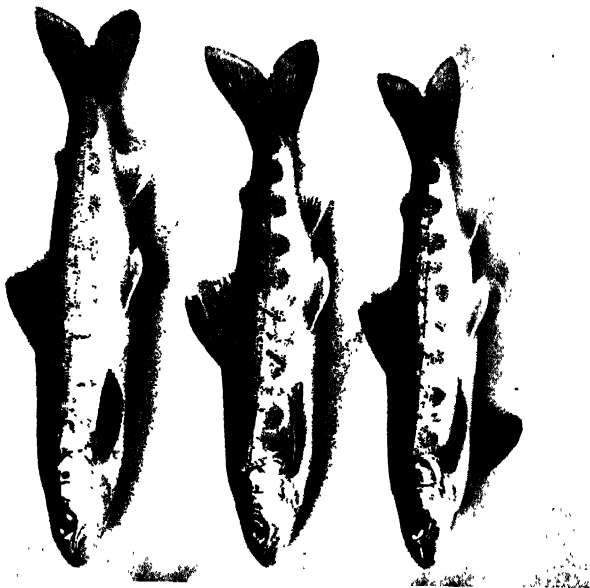
When Salmon first run up rivers they are usually in good condition, since they are fresh from their feeding grounds in the sea. They then present the graceful form and silvery appearance which are so characteristic of this fish. The flesh is firm and red and the tissues well stored with fat. After spawning, the fat having been expended on the development of the ovaries and testes, the flesh becomes pale and watery, the silvery colour is replaced by a dark red tint, and in the males the front teeth become enlarged, the lower jaw hooked and the snout prolonged. The skin of the back becomes thick and spongy, so that the scales become embedded in it. Large black spots edged with white appear on the body, which is spotted and mottled with red and orange. Such fish are termed "red fish," and the females, which are darker than the males, are called "black fish." "Kelt" is the general term applied to spent fish.

On the spawning ground the fish makes a trough by lashing



P. 88.

1st year.



P. 213.

2nd year.

Wye Salmon Parr. (p. 213)

Wye Smelts. (p. 221).

Showing pair markings when scales are removed.



movements of the shoulder, in this the eggs are laid and fertilised. The female then covers the eggs with gravel until a mound is formed containing the eggs. The whole process is repeated at intervals of a few minutes, the fish gradually working upstream. The spawning beds are known as "redds," and that of one pair of fish may be several feet long.

The season for spawning is autumn and winter, from September to January, its chief period being November to December. A mature female Salmon produces from 800 to 900 eggs for every pound of its weight; sea fish weighing 20 lbs. will have about 17,000 ova. The fish prefers shallows adjacent to deep pools, to which they can retire in case of necessity. The act of spawning is very exhausting, especially for the males, so that few of them survive to spawn a second time. Hutton says that probably not more than a quarter of the eggs are fertilised. The eggs are large (Plate 66), measuring 6 to 7 millimetres, and they are enclosed in a tough, elastic membrane. The period of incubation varies with the temperature, lasting from five to twenty-one weeks. It may be artificially prolonged by cold, and this allows of the successful transportation of ova to distant places such as New Zealand and Australia. The embryo when hatched measures about 1·6 centimetres; the yolk is absorbed in from four to eight weeks, when the fish attains a length of 2·6 centimetres.

The fry when provided with the yolk-sac are known as alevins, and while the yolk is being absorbed they continue to live between the stones of the redds. When they leave the redds they are about an inch long; they live in shallow water, attaining a length of 3 to 4 inches in a year and 5 to 6 inches in two years (Plate 88). In this stage the young Salmon are known as Parr: these may be considered as larvæ. In this condition the fish is distinguished by 10 to 11 dark bands which, in the form of long oval patches, cross the body at right angles to the lateral line, which divides them nearly equally. Between the parr

marks there is a red spot, and on the gill cover there are two round black spots and one behind the eye (Plate 92). Scales are formed during the first summer; round the nucleus zones of growth appear defined by ridges. The rings of growth are at first complete, but in the first winter ridges are formed only in the anterior region of the scale. A great deal of information as to the growth and habits of the Salmon has been derived from the study of scales, notably by Hutton in the case of the Wye Salmon (Plate 91). After the first winter the annular ridges are formed again, and a succession of these summer and winter groups of ridges gives an easy and reliable test of the age of the fish. From the scale readings we can now tell when the fish was hatched, how many years it spent in the river, how many years in the sea, and how often it has returned to the river for spawning.

In British waters a small number of parr are converted into the next stage—the migratory smolt—at the end of the first year or the beginning of the second year, as in the Hampshire Avon, but the great majority only change when two years old, and about one-fourth remain in the parr stage until the third year. According to Dahl, in southern Norway most of the parr migrate to the sea when two or three years old, but farther north the migratory instinct is not felt so early in life, and near the Arctic Circle some of the fish remain four or five years in the river before they reach the smolt stage. Hutton's figures for the Wye, based on the examination of a large number of scales, are : $7\frac{1}{2}$ per cent. migrate when one year old, $88\frac{1}{2}$ per cent. when two years old, and only 4 per cent. remain in the river for a third year. In no case was a four-year-old smolt met with on the Wye. Malloch found that in the winter months parr leave the shallow water and rest under the stones, where they appear dazed or sleepy. Parr continue to grow during their life in fresh water, and some of the males may even become mature and take part in spawning before migrating to the sea. The change into the smolt takes place when the fish are from

8 to 17 centimetres in length. The parr marks and orange ground colour are lost and the fish takes on a silvery appearance.

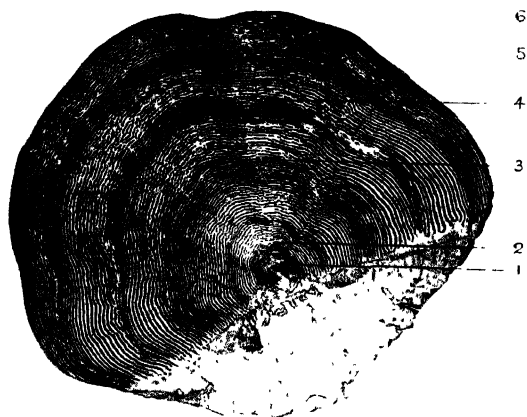
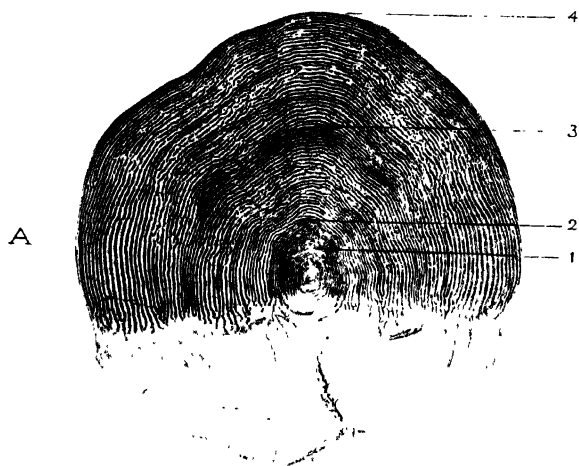
The colouring of the fish in the parr stage is of a pigmentary nature in the true skin and can be seen through the scales, which are then transparent. When the migratory instinct seawards possesses the fish, the thin "skin" which covers each scale changes and a silvery colouring matter appears in it. At first the original parr markings can be seen through this, but as the silvery deposit becomes more pronounced the parr markings are obscured. They can, however, be seen if the silvery scales of the smolt be removed (Plate 89). These smolts drop down the rivers, and on reaching the estuaries pass out rapidly into the open sea. The smolt is very like a young River Trout, but it has a forked tail and the body is not so deep compared with the length; in the Brown Trout at the same stage the orange ground colour persists, red spots surrounded by a light zone become prominent along the lateral line, and other red and black spots appear as the parr markings disappear, whereas the smolt becomes more and more silvery, as does the Sea Trout.

The smolts of the Salmon and Trout are not easily distinguished, but those of the Trout possess a large number of black pigment spots extending below the lateral line. In the open sea smolts grow rapidly on a diet of sand-eels and herring, so that when they return to the rivers, after a year's sojourn in the sea, they are not less than 16 inches in length or $1\frac{1}{2}$ lbs. in weight, and some are much larger than this and may even be 12 or 14 lbs. in weight. The Salmon on its first return from the sea is known as grilse. At this stage they have all the characters of the adult Salmon, the parr marks having finally disappeared. The study of the scale is now of importance. It is found that the ridges on the scales during parr life in the rivers are fine and the spaces between them narrow. In the sea as a smolt the deposition is greater, and the scales become enlarged by broader ridges with wider spaces. Winter in the sea is shown by short

arcs as in the parr. In the winter fish as a rule grow little or not at all. The first return to the river may be at the grilse stage or may be deferred to the Salmon stage. According to Hutton and others, the grilse may be defined as a Salmon which has spent one winter at sea. The greater proportion of the young Salmon spend their first two years in the rivers (parr) and one year in the sea (smolt), so that when they first return from the sea they are three years old (grilse). Grilse come up from the open sea in large shoals, and many ascend the rivers in summer to spawn in the autumn, returning to the sea as grilse kelts in winter or early spring. The average length of a grilse is about 2 feet. Many grilse do not ascend the rivers; these fish remain in the sea until the winter or spring, when they are nearly four years old and ascend the rivers as small spring salmon. These are very like the grilse in size and appearance, but they do not spawn until the following season. It is also probable that some fish stay in the sea for several years and attain a considerable size and weight, returning to the rivers as maiden salmon when four, five or six years old. The act of spawning is recorded on the scale (Fig. A, Plate 101). Johnston showed that the fraying of the scale occurred in the kelt, and this, on subsequent recapture of the fish, is found to be converted into a spawning mark and can be traced in other Salmon. The fraying of the scale is considered to be an expression of the physiological drain on the system of the fish caused by the ripening of the eggs. In males and young females this spawning mark is not always clear. According to the evidence of the scales the Salmon does not spawn as often as was at one time supposed. Some may spawn in successive seasons, going back to the sea as kelts, passing only a few months there before returning to spawn; others may miss a year, or even two years may elapse before they return to spawn for a second time. On many rivers a large proportion of Salmon spawn once only; Malloch found on the Tay that 80 per cent. of the



Salmon. Male and female. (J. L.)



Pl. 91.

Scales of Salmon. (p. 220).

P 223.

- A Four years old, which had spent 2 years in river and 2 years in sea.
 B Six years old, which had spent 2 years in river and 4 years in sea.

spawners were maiden fish. Salmon rarely live to be more than eight or nine years old, and size is by no means a certain indication of age, since the largest Salmon are those which have spent a longer time in the sea, where food is abundant and growth rapid. In the Tay fish from 30 to 40 lbs. weight are considered to be seven or eight years old. Salmon of more than 80 lbs. have been recorded, the record Scottish fish being 84 lbs. in weight. Hutton described three maiden salmon from the Wye of 40, 42 and 44 lbs. weight respectively as being six years old and having spent four years in the sea (Plate 87).

The life of the Salmon at sea is still problematical. Very few are captured and they are very rarely taken in the trawl. They probably lead a predatory life at no great depth or distance from the coast.

Salmon have been successfully marked with numbered labels and their migration traced. The return of the smolts as grilse and young Salmon, and the kelts as spawners, has been thus established. In the majority of cases the Salmon return to the same river. In 1905 Johnston marked 5,500 smolts in the river Tay. A large number of these were subsequently recaptured, some one year, some two years, and others three or four years later. Every one of these fish showed its life-history clearly marked on its scales, so that the scale-reading corroborated the marking experiments in a remarkable manner.

According to Calderwood Salmon generally, both grilse and older stages, visit the coastal waters periodically but do not all enter the rivers. Only the fish about to spawn ascend the rivers to any extent, though undoubtedly some non-spawners extend their migrations into fresh water. After all, the Salmon spends a great deal of its life at sea, and the marking experiments prove that it may wander for many miles.

The Sea Trout apparently does not wander so far from the river in which it was reared.

The Salmon has many enemies at all stages of its life-

history, and of these man is the greatest. The eggs are devoured by eels, and subject to drought owing to improved drainage and, in some cases, to the abstraction of water for industrial and water-supply purposes. Perch, Pike and Trout, and many species of birds prey on the young fish during the alevin and parr stages. When they get to the sea they are said to be attacked by the various species of the Cod family, but I know of no definite evidence of this. Cormorants, seals and porpoises are more likely enemies. But the pollution of rivers probably is more detrimental to the growth and productivity of our Salmon fisheries than all other causes taken together. No one who knows the condition of the estuaries of our rivers which drain large manufacturing areas can doubt this. Many rivers in their tidal reaches are little better than open sewers, and as instances the Mersey, Thames and Clyde may be given. Here the Salmon has a terrible struggle to get through a section of the river where sewage drifts up and down with the tide and there is a volume of water practically devoid of oxygen. Rivers less seriously polluted are the Tyne, Ribble and Lune, but even here there is a marked falling off in the number of Salmon which are able to force their way up to the spawning grounds. In certain instances of late years the enforcement of the provisions of the Rivers Pollution Prevention Acts has produced some amelioration in the non-tidal portions of our rivers, but there is yet no effective method of preventing serious pollution of tidal waters.

Fresh-run Salmon have usually small parasitic crustacea known as sea-lice attached to the body. These creatures are really Copepoda, and are usually females with the egg-sacs attached and about $\frac{3}{4}$ of an inch in length, the males being scarce and only about one-third as long. They feed on the blood of their host. They are unable to live in fresh water, and after a few days of river life they drop off. Consequently they are characteristic of fresh-run Salmon. In 1906 the Scottish

Fishery Board got two grilse with sea-lice attached straight from the sea and placed them in a tank of salt water. Fresh water was pumped into the tank and all salt water eliminated. The sea-lice remained on one grilse for four days, and on the other for five days. Salmon have been caught on the Wye at Builth, 115 miles from the sea, with sea-lice attached. This, according to Hutton, and allowing for an adverse current of 4 miles an hour, means that the Salmon can run up the Wye at the rate of 130 miles per day.

In fresh water another species of Copepoda attacks the gills of the Salmon. These are even less shrimp-like than the sea-lice and are frequently termed "maggots." These Copepoda can live in the sea, and fresh-run Salmon which have previously visited fresh water usually have them attached to their gills. Salmon in fresh water are frequently subject to disease, and this sometimes attains formidable dimensions. This Salmon disease is due to a specific germ which Patterson calls *Bacillus Salmonis pestis*. These bacilli invade the tissues of the fish where the skin has been injured, and multiplying rapidly form an area of mortified flesh on which a fungus known as *Saprolegnia ferox* grows readily. The white patches of this fungus are the visible sign of the Salmon disease.

Salmon were much more abundant formerly than they are now, but I have not been able to trace any definite proof of the assertion which is often made, that it was a regular condition in indentures of apprenticeship that salmon should not be given to the apprentice for dinner more than so many times a week.

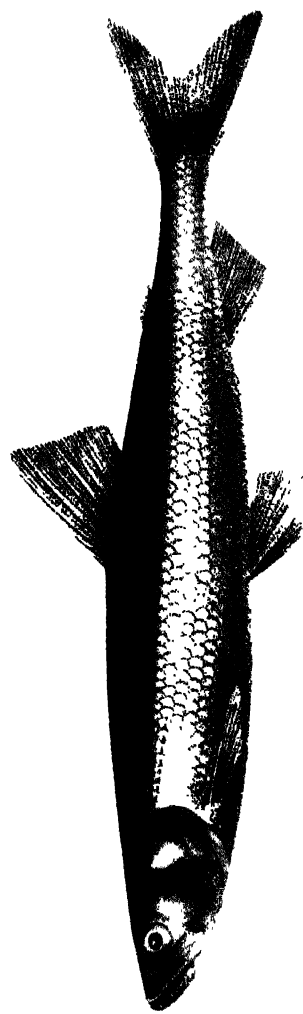
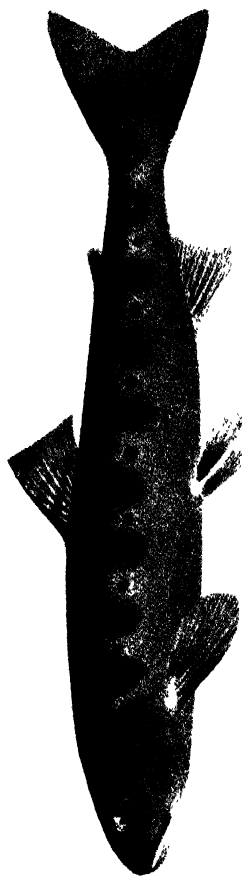
Artificial propagation has been extensively resorted to, particularly in America. The Americans, however, are much more addicted to a belief in the efficacy of artificial hatching of various species of fish than we are in Great Britain. A visit to a Salmon Hatchery during the height of the hatching season can be thoroughly recommended, and no one who has an opportunity of doing so should omit to make such a visit, since

much more may be learnt of the eggs and young of the Salmon in one day in this way than in any other fashion.

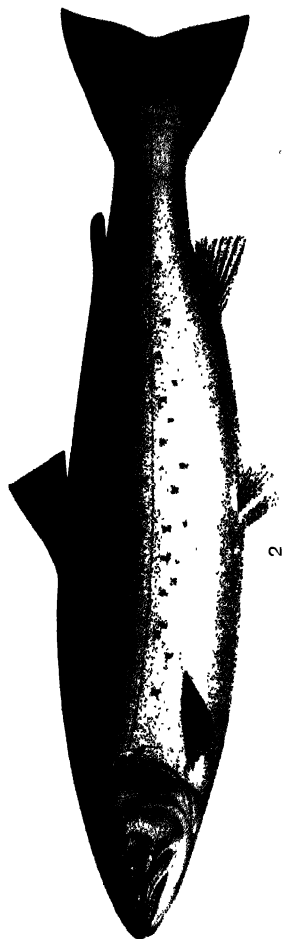
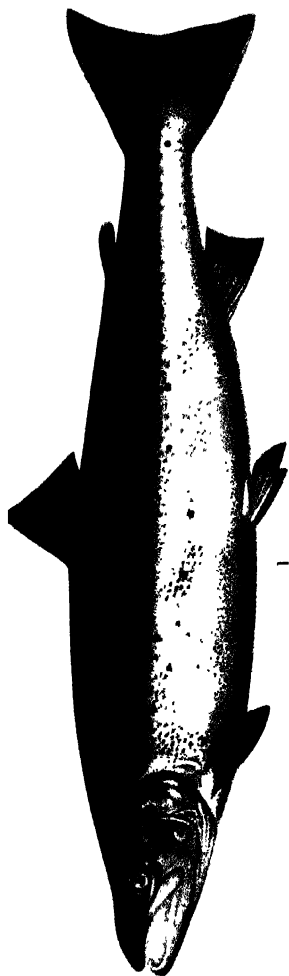
Of the European Salmon Fisheries that of Great Britain is by far the most important. The total catch of the whole of Europe, excluding the British Isles, amounts to 3,000,000 lbs. weight per annum; while of the British Salmon Fisheries 3,500,000 lbs. weight are sold in Billingsgate Market alone, to say nothing of the other large distributory centres. Hutton says that if our Salmon Fisheries were properly managed the catch could easily be doubled or even trebled, without any risk of diminution of the future supply. Salmon fishing is popularly supposed to be a relaxation of the "idle rich," and while it is true that rod fishing for Salmon is in many cases a somewhat expensive hobby, it must not be forgotten that more fish are caught by netting than by rod and line. In 1913, in the Wye, 3,538 Salmon were caught by rod and line and 6,408 fish in nets. In addition to this, 25,000 fish were caught in nets in the Severn, many of which were Wye-bred fish. Hutton estimates that in 1913 the real proportion of rod-caught to net-caught fish of Wye origin was 3,500 to 20,000, or 1 to 6. Generally speaking, throughout the country the net-catch of Salmon is ten times that of the rods. In 1913 the licences and rates paid to the Wye Board of Conservators by rod fishermen were £1,807 compared with £489 derived from the nets.

Salmon, though from one point of view an expensive article of diet, is really not uneconomical when all the facts are taken into consideration. The waste, *i.e.* the bones and skin, in Salmon amounts to 23 per cent. of the total weight; in cod the waste is 49 per cent. The flesh of the Salmon is very nourishing, and at 2s. 6d. per lb. gives 292 food calories for each shilling, compared with 166 calories for every shilling spent in purchasing cod at 1s. per lb.

The record for this species caught by fair angling in the British Isles so far weighed 64 lbs. This fish was caught by



Sal
Sm



Miss G. W. Ballantine in the River Tay on October 7, 1922. A 59½-lb. salmon from the River Wye, caught by Miss D. Ll. Davey on March 19, 1923, is the record spring Salmon. Two other fish over 60 lbs. have been caught in the Tay—61½ lbs. by Mr. T. Stewart, October, 1907; and 61 lbs. by Mr. J. Haggart, March, 1870. Only one other authentic 60-pounder is on record; it was taken in the River Eden by Mr. Lowther Bridger in 1888. A salmon estimated at 80 lbs. was found dead in the River Wye in May, 1920; it had been hooked and lost, as the minnow was still in its mouth. The nets have accounted for heavier salmon than the rod. In 1869 one of 84 lbs. was taken by W. Walker at Port Allan; and Mr. W. L. Calderwood has passed as authentic a monster weighing 103 lbs. taken under doubtful circumstances in the estuary of the Forth in 1901 or 1902.

The Trout (*Salmo trutta*).

There is no family of fishes which offers so many difficulties in the distinction of species as the Salmon family. There is so much variation due to age, sex, food and environment that there is even now considerable diversity of opinion as to the number of distinct species. A large number of different species have been described from time to time by ichthyologists, and in no case has this been more marked than in the trout.

Gunther describes ten distinct species—the Sea Trout or Salmon-trout (Plate 93) (*S. trutta*), the Sewen (*S. cambricus*), the Common River Trout (Plates 94, 95, 96, 97) (*S. fario*), the Phinock or Eastern Sea Trout (*S. brachypoma*), the Galway Sea Trout (*S. gallivensis*), the Orkney Sea Trout (*S. orcadensis*), the Great Lake Trout (*S. ferox*), the Gillaroo of Ireland (*S. stomachicus*), the Welsh Black-finned Trout (*S. nigripinnis*), and the Lochleven Trout (*S. levenensis*). The results of modern research do not support the view that all these forms are distinct

species. An extreme view is that the Salmon and all the trouts are varieties of one species. Meek says that a study of the distribution supports the view that the Salmon, Sea Trout and River Trout are three distinct species. Tate Regan groups all the British trouts under one species, *Salmo trutta*, and this view is, in the author's opinion, correct.

The Trout differs in its distribution from the Salmon in that it is not found in North America. It ranges from Iceland and the north coast of Europe to the Mediterranean, including Corsica, Sardinia and Algeria. It extends eastwards through Persia to the northern slopes of the Himalayas, and migratory trout are found in the Black, Caspian, and Aral Seas.

The Trout is found all round the British Isles and in all suitable lakes and rivers. In many of the latter, of course, it has disappeared as the result of pollution.

The Trout differs from the Salmon in its less graceful form, its deeper caudal peduncle, in its tail fin not being forked, and in the fewer number of scales from the posterior end of the adipose fin downwards and forwards to the lateral line (13 to 16 rows in the Trout).

The colour is subject to extreme variation (Plate 93), but in general the Sea Trout is silvery and the non-migratory Trout brownish; the latter, or at any rate some of its varieties, are known as the Brown Trout. Sea Trout, if introduced into land-locked lakes, will live and spawn in fresh water, and the River Trout which have been introduced into New Zealand waters have made their way to the sea and become anadromous. In some instances the trout of our estuaries are intermediate in appearance and habits between the Sea Trout and River Trout. In some of the Welsh estuaries the variety known as the Sewen attains a large size and may easily be mistaken for a Salmon, and in fact is sometimes sold as such to the unwary. In addition to the other points of difference

mentioned above, the Sea Trout usually has more numerous blackish spots on the upper part of the body than a salmon of the same size. The characters which serve to differentiate the different varieties of Sea Trout can hardly be entered into here. In many cases even an expert could not distinguish an individual fish unless he knew the locality it came from ; with a number of fish it might be possible to do so. The Sewen of Wales differs from the Sea Trout of the East Coast in having a long head, a larger mouth with stronger jaws, larger fins, with the lobes of the caudal more produced.

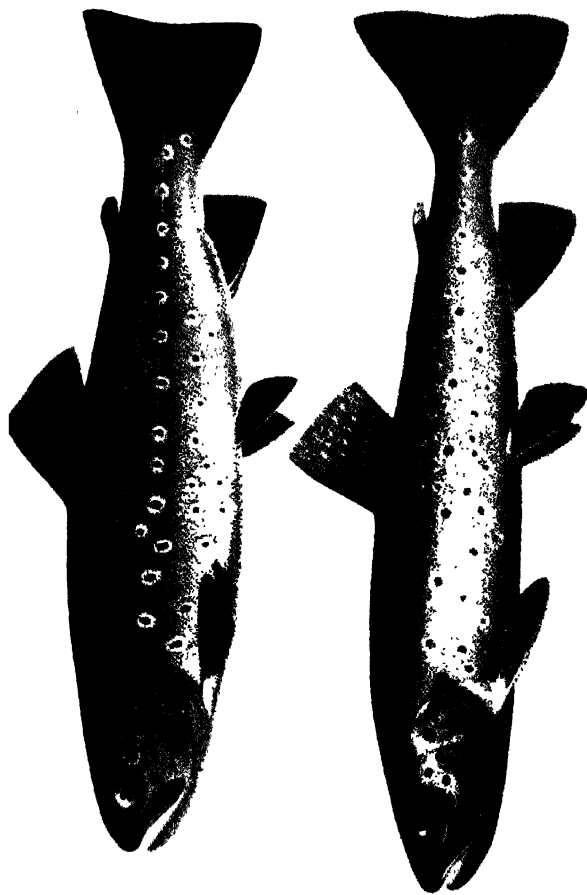
The Sea Trout is less marine in its habits than the Salmon, remaining for the most part in the vicinity of the coast, and in spring and summer large shoals may be observed in suitable places in estuaries, frequently leaping out of the water. They spawn in fresh water from September to January, the chief season being October and November. They are often earlier than Salmon in the same river. The Sea Trout do not remain long in the rivers after spawning, and, unlike the Salmon, they feed in fresh water. The spawning habits are like those of the Salmon. The period of incubation is long ; the eggs hatch out in spring, and for a time the larvæ remain in the gravel, during which stage of their life-history the yolk-sac is absorbed. The young remain in fresh water for over two years, and in April and May of the second year they migrate slowly to the sea. At this time they are from 4 to 8 inches in length. The young trout are similar in appearance to salmon parr, the chief points of difference being that the trout has the spots more numerous and more widely distributed, while the regular series behind the eye is absent. The pectoral fin is orange-coloured, and the anal fin has a white anterior edge bordered behind by a dark streak. The caudal fin is less forked, the middle caudal rays being two-thirds as long as the longest.

The Sea Trout passes through a smolt stage. These are not easy to distinguish in certain cases from the Salmon smolt,

but in the Trout the maxillary nearly reaches the vertical from the posterior edge of the eye, whereas in the Salmon it extends only to the posterior edge of the pupil.

The Sea Trout smolts do not go far out to sea, and some of them run up in autumn after having been only a few months at sea. A large number of local names have been given to Sea Trout. A collection of these names would make a formidable list. In addition to the Sewen and Phinock already mentioned, there are the Orange-fins (smolts of Sea Trout); Black-tails or Peal (Devonshire), which have a dark caudal fin; and Whitefish, Whitling, or Herling, a Sea Trout about 18 to 20 inches long and of silvery appearance. Other local names for the Sea Trout are Truff (Devonshire), Scurf (on the Tees) and Bull Trout.

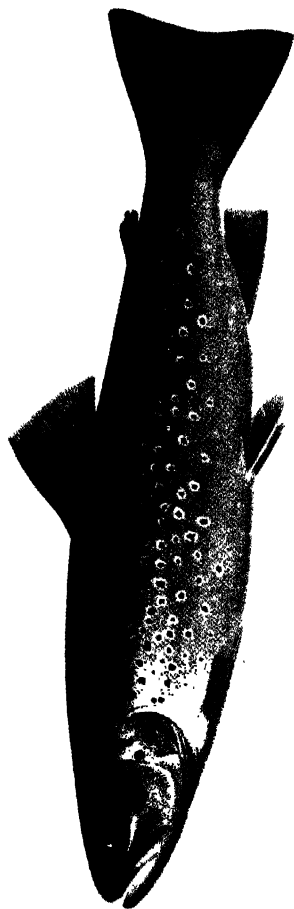
In the Orkneys there is a variety (*S. orcadensis*) intermediate in appearance and habits between the River and Sea Trout. The non-migratory or River Trout exhibits many distinct forms according to its habitat. Tate Regan finds in all these "a remarkable variability in those features which are influenced by habits or environmental conditions, but a no less remarkable constancy in those which are not so affected." Of the more distinctive varieties of non-migratory trout the following deserve mention. The Great Lake Trout (*S. ferox*) is, according to Tate Regan, in no way different from a large Brook Trout. It is found in Scotland, Wales and Ireland. The Lochleven Trout (*S. levenensis*) is considered by many writers to merit specific rank, but here again Tate Regan finds no constant specific characters to distinguish it from other non-migratory trout. In certain of the Welsh mountains there is a dark variety known as *Salmo nigripinnis*, but the colour of trout is subject to such extreme variation according to the environment that no reliance can be placed on it as a specific character. The Gillaroo (*S. stomachicus*) of Irish lakes is distinguished by the numerous red spots, and is said to live on



Pf. 94.

Golden Trout with large spots.
Mountain Black Trout.
(p. 227).

(230)



Pl. 95.

Golden Trout from lowland stream. (p. 227).
Young Pike. (p. 233)

C 231.

shellfish and have a hard and thick-walled stomach as a result of this diet. It is found in Loughs Neagh, Melvin and the Galway lakes. Gunther relates that once he went to examine at a fishmonger's a good collection of Gillaroo from Lough Melvin, and on testing them he could feel the hard stomach by pressing with his fingers. He purchased a fine specimen, and afterwards cut it open to examine the stomach. The walls of the stomach were quite thin, but its contents consisted of a quantity of shot wrapped in newspaper, an advantage to the fisherman in the case of fish sold by weight!

The record Trout caught by fair angling in the British Isles weighed 39½ lbs. It was caught in Loch Awe by Mr. W. C. Muir in 1866. No other Trout over 30 lbs. appear to have been caught, and the next heaviest is the 26 lbs. 2 ozs. Lough Ennel Trout taken by Mr. W. Meares, July 15, 1894. Some big Trout have been taken in Loch Rannoch, including a 22-pounder taken by Mr. F. Twist in 1867, and one of 21 lbs. by Miss K. H. Kirby, July, 1904. The largest Trout taken from a river weighed 20 lbs., and was caught by the Earl of Craven in the River Kennet at Newbury. It was exhibited at the International Fisheries Exhibition, 1883. Two of 18 lbs. have also been caught, one in the New River by Mr. J. Briggs, August 28, 1907, and the other by General T. Hickman in the River Test at Broadlands, 1922. What is probably a record "bag" was taken by Sir Aubone Fife, Mayfly fishing on the River Kennet in 1903—16 Trout weighing 56 lbs., best three fish weighing 15 lbs. together.

ACCLIMATISED MEMBERS OF THE SALMONIDÆ.

1. The Brook Trout (*Salvelinus fontinalis*).

The Brook or Speckled Trout (Plate 98) is one of the most beautiful, active and widely distributed of the American

trouts. It was introduced into waters on the European Continent in 1889, and has also been tried in some British streams. In Britain it invariably disappears; possibly it descends rivers and escapes out to sea. On the Continent it has acclimatised itself more thoroughly than any other American species. It is easily recognised by its coloration, the back with the dorsal and caudal fins being mottled and barred with black or dark olive. This coloration, however, like all other salmonoids, is very variable.

The original home is the Atlantic drainage area of North America. In the United States the largest specimen recorded was one of $12\frac{1}{2}$ lbs. weight from the Rangeley Lakes, Maine; but the Canadian record is held by a still larger fish, one of $14\frac{1}{2}$ lbs. from the Nipigon river, a Canadian tributary of Lake Superior. This trout is now hatched and reared for consumption in the New York and Boston markets by commercial trout farmers, operating for the most part in the eastern states. It is a good sporting fish, with a flesh of fine flavour. When first introduced on the Continent this species and the closely allied Rainbow Trout were enthusiastically welcomed. The ease with which spawning operations could be conducted, and the rapid growth of the fish, made it at first a general favourite. In confined waters, such as small lakes, it easily attains a length of 6 inches in its first year, and in its second year it not infrequently weighs from half a pound to even a pound in weight. After its second year the rate of increase of growth diminishes materially. The great drawback to its introduction into strange waters are its cannibalistic habits and its lack of hardiness, which, especially at spawning time, proved a considerable hindrance to successful cultivation and acclimatisation. The American Brook Trout has been introduced into many small lakes in the Clyde area, and also into Loch Lomond, where it maintained its identity for a time but did not thrive. It has been distributed throughout Renfrewshire and Ayrshire, and thrived

for a time in the rivers Ayr and Irvine and the waters of Borland, Kilmarnock, Cessnock, Carmel and Alnwick.

2. The Rainbow Trout (*Salmo irideus*).

The natural home of the Rainbow Trout (Plate 98) is in certain tributaries of the Sacramento River. But the Americans give the name of Rainbow Trout to the fish known as *Salmo shasta*, and what we call a Rainbow Trout is known to them as a Steelhead Trout, and this is the species (*Salmo irideus*) which has been more or less successfully acclimatised in British waters and on the Continent of Europe, where it was first introduced from the United States in 1882. This species may be recognised most easily by the spots which cover the caudal fin and by the handsome reddish or iridescent bands which are seen on the side of the body. The comb-like and toothed vomer is also characteristic. The branched rays in the anal fin are often more numerous (9 to 11) than in the British Trout. This species was also very successful when introduced into Europe, and it commended itself to fish culturists by the ease with which it could be hatched and reared artificially, by its rapid growth and the fact that it could stand high water temperatures, much higher than our indigenous Trout were able to withstand. Moreover, it is a spring spawner, laying its eggs in March and April, so that it could be handled in the hatcheries after the spawning of the indigenous Trout was completed. The eggs are small and more numerous than those of the native Trout, from 8,000 to 9,000 for each pound weight of the adult.

A great drawback to the acclimatisation of the Rainbow Trout lies in the fact that it is a migratory species, and after the owner of a certain stretch of water has gone to the expense of hatching, rearing and planting out this species, he finds that it suddenly disappears. On the Continent it has been found repeatedly in the coastal waters of Denmark and Schleswig-Holstein, whence it has unquestionably migrated from other

districts. The difficulties incidental to artificial hatching and rearing seem to be accentuated in the case of this fish, and serious losses have been sustained by those who have undertaken its culture.

THE CHAR (Genus *Salvelinus*).

Char (Plate 99) are distinguished from Salmon and Trout by the vomerine teeth being present as a group on the head of the vomer ; in the genus *Salmo* there are teeth on the body of the vomer as well as on its head. Char have smaller scales than trout, and there are no black or brown spots on the former fish. Formerly there was considerable difference of opinion as to the exact number of species of Char found in British waters. Gunther enumerates six distinct species, but the modern tendency is to regard each local group of Char as distinct, so that Tate Regan, who is our leading authority on this genus, enumerates no fewer than fifteen distinct species.

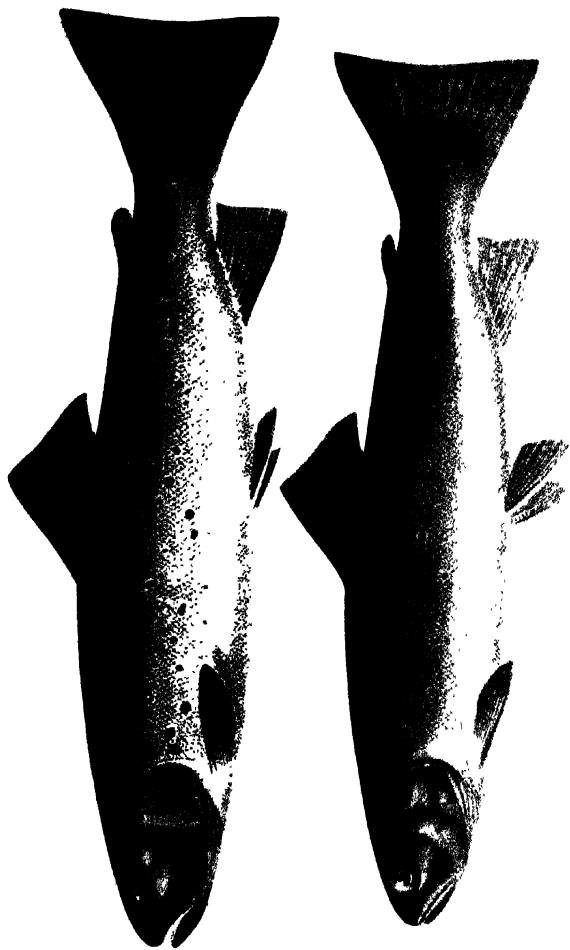
The Char is decidedly a cold-water form and extends into arctic and alpine regions. In arctic regions it has been found as far north as 82 degrees ; in the British Isles it has been found in lakes over 1,500 feet above the sea-level. The common ancestor of our Char was probably a migratory form with habits similar to the Salmon and Sea Trout, that is, spawning in fresh water but living to a greater or less extent in the sea. Our Char to-day are typical of mountain lakes which are always cold and often deep, and they are found where such lakes occur in England in the Lake District, in North Wales, in Scotland and Ireland. In recent geological times they have been cut off from access to the sea, and are now entirely fresh-water forms.

The arctic Char are still anadromous in their habits, like the Salmon. Since the time when the Char have become isolated in mountain lakes or groups of lakes they have developed along certain lines, so that each isolated group presents characteristics



Pl. 96.

1. Old male Trout with hook. 2. Trout from forest stream. 3. Young Trout. (p. 227) Q 234.



17. 97

Trout from moorland stream
Common Trout.
(p. 227).

Q. 235

which enable us to recognise such a group as a distinct species. Few people will have an opportunity of studying more than one or two of the fifteen different species. Personally the author is acquainted with the char of Lakes Padarn and Peris in North Wales, and that of Lake Windermere.

The account which follows is based on the researches of Tate Regan, who has paid particular attention to the Char for some years.

Tate Regan divides the Char into British and Irish species, and the characteristic features given below are abbreviated of each genus. The amateur will certainly find it difficult, if not impossible, to identify Char unless the locality from which they come is known. In what follows, therefore, no attempt is made to give a complete account of the characters which separate the Char from one another. A list of the different species with their habitat is given; for fuller details special works should be consulted.

Char vary greatly in colour. The back may be bluish-grey or bluish-black, or olive, green or brownish. The abdomen is silvery white or orange or crimson, the shade depending on the sex, age and locality; the deep red colour is especially characteristic of the males in the spawning season. Pink, orange or red spots may be present, sometimes only below the lateral line, at other times covering the body and even the dorsal and caudal fins, which are usually greyish or blackish. The caudal fin is often tinged with red. In some cases the lower fins are red, with the anterior edge white; the pectorals usually having a dark greenish shade near the white edge.

Char prefer cold water; a temperature above 59° F. is fatal to them. They grow to a weight of nearly 3 lbs. in a large lake like Windermere. Char are shy, deep-water fish; their life-history is somewhat obscure, as they are rarely seen in many of the lakes which they are known to inhabit. They are caught by anglers, usually with an artificial fly.

Spawning takes place from November to February, but the different species have different habits and times for spawning. They spawn in shallow waters in the lakes they inhabit, or even run up tributary rivers, forming redds or spawning beds in a similar manner to the Salmon. The winter spawning habit is an indication of the northern origin of the fish. In addition to those char which spawn in shallow water there are probably some species which have acquired a deep-water spawning habit. The shallow-water spawners deposit their eggs on gravel. The eggs are large and not numerous; incubation lasts from nine to ten weeks, and after hatching the young larvæ continue to live for four weeks on the yolk contained in their yolk-sacs, prior to hunting for their food.

This food varies largely. The larger char are predatory fish, but their food may consist of bottom-living molluscs and crustacea, or they may even be purely plankton feeders, as one would expect from the presence of gillrakers. The size of the fish depends to a large extent on the nature and abundance of the food supply. Char are fish of a delicate flavour (at any rate, the Welsh Char or Torgoch is) and are much esteemed as an article of diet.

1. Willoughby's Char, or the Windermere Char, *Salvelinus willoughbii*, is found in Lake Windermere and other lakes in the English Lake District. They inhabit the deeper parts of the lake, but on summer evenings they swim at the surface. From March to September they are caught in large numbers in nets and are sold fresh or potted. The breeding season extends from November to February, and there are two groups of spawners. One group consisting of the smaller adults make their redds either in the River Brathas or in shallow water near the banks of the lake; the later spawners are the larger adults, and they spawn in comparatively deep water.

The char found in three lakes in south-west Scotland, namely Lochs Grannoch and Dungeon in Kirkcudbrightshire

and Loch Doon in Ayrshire, as well as in the following lakes in the Highlands of Scotland, are referred by Tate Regan to this species: Loch Builg in Banffshire; Bruiach in Inverness-shire; Morie in Rosshire; Borollan, Loyal and Baden in Sutherlandshire.

The char in Loch Fada in North Uist are also very closely allied to this species.

2. Lonsdale's Char, or the Haweswater Char (*Salvelinus lonsdalii*), is a much smaller species, attaining a length of 7 inches and a weight of 3 ounces. It differs from the Windermere Char in the longer and more pointed snout, smaller eye, narrower opercular bones, and larger fins.

3. The Torgoch (*Salvelinus perisii*) inhabits two lakes near Llanberis at the foot of Snowdon, and is said also to be found in Llyn Bodlyn in Merionethshire. The Welsh name of Torgoch means Red belly. It grows to a length of 10 inches and a weight of 6 ounces. They spawn in November, in a small stream which connects the two lakes Peris and Padarn. In summer they occasionally appear at the surface in shoals.

4. The Struan Char (*Salvelinus struanensis*) is found in Loch Rannoch in Perthshire. It is a brilliantly and beautifully coloured species; above the lateral line the body is black shot with metallic blue, below claret shaded with steel blue. There are indistinct salmon-coloured spots, about twenty above the lateral line and sixty on or below it. The Struan Char is a bottom feeder; it has a large eye characteristic of deep-water forms.

5. The Haddy (*Salvelinus killinensis*) of Loch Killin in Inverness-shire is one of the most distinct forms of Char in the British Isles, and is one of the six species recognised by Gunther. The fins are large, especially in the males. The scales are smaller than in most other char, numbering from 180 to 220 along the lateral line. The coloration is dark; the back and sides are olivaceous, the belly silvery or yellowish. A

single specimen of this species has also been obtained from Loch Roy in Inverness-shire.

6. The Large-mouthed Char (*Salvelinus maxillaris*), a native of a small isolated loch under Ben Hope in Sutherlandshire, is a very distinct species with a long maxillary bone, which extends far behind the eye in adult males and from which its name is derived.

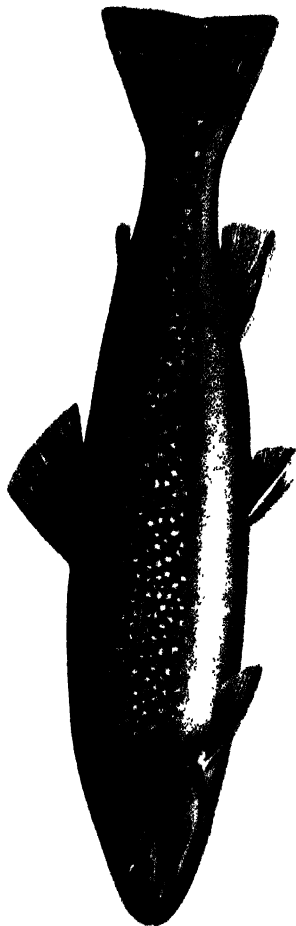
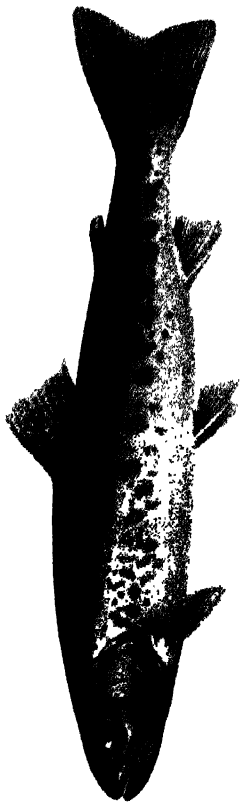
7. Malloch's Char (*Salvelinus mallochii*) occurs in Loch Scourie in Sutherlandshire. It is a short-headed, blunt-snouted, small-mouthed char with small scales, from 188 to 200 along the lateral line.

8. The Orkney Char (*Salvelinus inframundus*) is, according to Tate Regan, probably now extinct. It was formerly found in Loch Hellyal in the Island of Hoy, but attempts to capture it in recent years have been uniformly unsuccessful. There are no other chars in the Orkneys.

9. The Shetland Char (*Salvelinus gracillimus*) is easily distinguished from all other British species by its elongate body, the greatest depth being about one-sixth of the length. It is found in Loch Girlsta, the only char loch in the Shetlands.

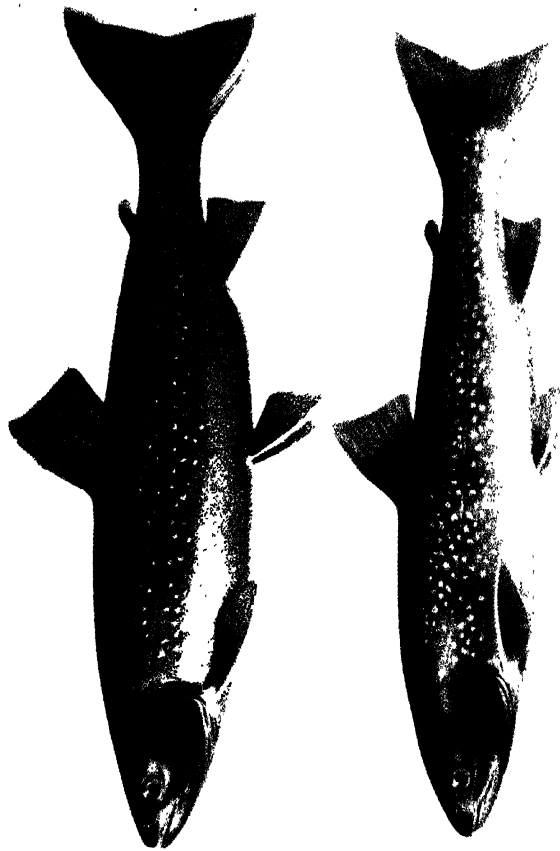
10. Cole's Char (*Salvelinus colii*), an Irish Char, is found in Lough Eask in Donegal, Lough Dearg, several lakes in Connaught, Loch Gortyglass in Clare and Lough Currane in Kerry. It grows to 8 inches in the smaller lakes, in other cases to a foot in length. This species is almost identical with the Windermere Char. In Lough Eask it spawns in November, and at that time was formerly captured in large numbers by the country people.

11. Gray's Char (*Salvelinus grayi*) is the "Fresh-water Herring" of Lough Melvin in Fermanagh. This species has an average length of from 10 to 12 inches. It differs from the preceding species in having the body more compressed and deeper, the caudal peduncle shorter and deeper (its least depth nearly one-half the length of the head), the pectoral fins usually



Rainbow Trout. (p. 223).
 Brook Trout. (p. 231).

Q 238.



longer, the scales larger (128 to 162 along the lateral line), and the vertebræ fewer.

12. Trevelyan's Char (*Salvelinus trevelyanii*) is from Lough Finn in Donegal. It differs from Cole's Char in having a longer head, narrower interorbital region, produced pointed snout and strong dentition. Of the British species the Haweswater Char comes nearest to Trevelyan's Char.

13. Scharff's Char (*Salvelinus scharffi*) comes from Lough Owel in Westmeath. It is a silvery fish with the back bluish-grey. This Char grows to a length of a foot; the average weight is from 1½ to 2 lbs., but some attain a weight of 3 lbs.

14. The Coomasaharn Char (*Salvelinus fimbriatus*) receives its specific name from the long and numerous gillrakers. It is found in Lough Coomasaharn in County Kerry.

15. The Blunt-snouted Irish Char (*Salvelinus obtusus*) is recorded from Loughs Luggala and Dan in Wicklow, and Killarney and Accoose in Kerry. It attains a length of 8 inches.

The Lough-Neagh "Whiting," now extinct, was a species of Char. Described and figured in 1812 in Dubourdiou's "History of the County of Antrim," it was found impossible to obtain a specimen in 1837 in spite of a handsome reward being offered for one.

The Genus COREGONUS.

The genus *Coregonus* comprises a number of species known collectively as Whitefish. These species resemble one another very closely, and it would be difficult or impossible for any one not an expert to say with certainty to which species an individual fish belonged, unless the locality of origin were known. Since these fish are of only limited general interest, inhabiting as they do one or at most a few lakes, they are only dealt with very briefly here. Further information is contained in Tate Regan's book on "British Fresh-water Fish."

The "Whitefish" of this genus are very like herring in general appearance, but the presence of an adipose fin serves to distinguish them immediately from the Clupeoids. The species of *Coregonus* differ from other fresh-water Salmonoids in the following respects. The body is covered with scales of moderate size, larger than in the other genera. The mouth is small, and teeth if present are minute and deciduous. The dorsal fin is of moderate length and the caudal deeply forked

The Lochmaben Vendace (*Coregonus vandesius*).

A small species of "Whitefish," the Lochmaben Vendace (Plate 100) is of very restricted distribution, being confined to a few small lakes near Lochmaben in Dumfriesshire. This Vendace attains a length of 9 inches, and in form and colour it closely resembles a Herring. Of course it can be distinguished at a glance from the Herring by reason of its second dorsal adipose fin. In the Lochmaben Vendace the body is fusiform and compressed, the head pointed, with the mouth oblique and the lower jaw projecting. The branchial arches are provided with numerous long and slender gillrakers.

Tate Regan, who has studied this species at Lochmaben, gives much interesting information about the fish. From his account the following brief extract is made.

The Lochmaben Vendace is characterised by the deep body and rather large fins. The colour is silvery white, with the back greenish-blue. Sometimes this dark colour extends down to the lateral line, and the body below may be of a golden tint. The fish is gregarious; its food consists of small crustacea. In warm weather it retires into deep water, returning to the shoals in November. They are fished for by means of small-meshed seine nets, the best days for fishing being in dull weather and a smart breeze, when the fish leave the depths and swim near the banks against the wind.

Clubs were formed many years ago for Vendace fishing in the Lochmaben lakes, one for "gentry," the other for the plebs. The latter club consisted at times of as many as two thousand people. These clubs died out, but one was resuscitated about 1907, without, however, meeting with any marked success. The Vendace is considered a great delicacy. The inhabitants of Lochmaben are very proud of it, regarding it as a mysterious fish peculiar to its lakes.

Tradition has it that it was introduced there from the Continent by Mary Queen of Scots in 1565, but this is improbable for two reasons; the difficulty of transporting such a delicate fish for long distances, and the fact that this species is not found on the Continent.

The Cumberland Vendace (*Coregonus gracilior*).

This species is found in the English Lakes Derwentwater and Bassenthwaite. It is very similar in size and appearance to the Lochmaben Vendace, but according to Tate Regan has a more slender body, a shorter head and smaller fins, whilst the dorsal fin has usually more rays. Little is known of the habits and life-history of this fish, and it is not even known with certainty whether it is rare or abundant in these lakes. The local net fishermen do not catch them since they would require nets of a smaller mesh and have to fish farther from the shore than they are allowed to do at present. One was recorded from Bassenthwaite in June, 1935. "The first for half a century" (*The Times*).

The Lough Neagh Pollan (*Coregonus pollan*).

The Lough Neagh Pollan (Plate 103) is a rather well-known fish, since it is regularly exported from Ireland and is frequently exposed for sale in the Lancashire and other markets in

England. It differs from the Vendace in the lower jaw not projecting above the upper, and in the smaller and more numerous scales, 74 to 86 in the lateral line compared with 60 to 72 in the Vendace. The Pollan attains a weight of $2\frac{1}{2}$ lbs., but the average length is from 9 to 10 inches and the weight 6 ounces. They spawn in November and December, seeking hard ground at the bottom of the lake for the purpose. From spring to autumn the shoals approach the shores of the lake, when they are netted in large numbers.

The Lough Erne Pollan (*Coregonus altior*).

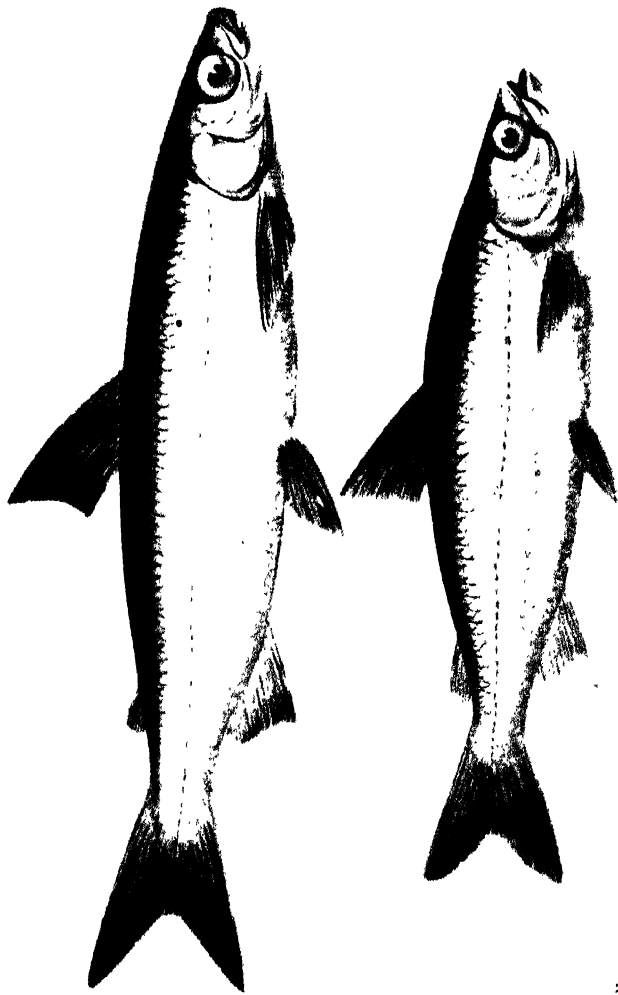
This species differs from the preceding in having a deeper body. The scales are often more numerous in a transverse series. It would be difficult, even for an expert, to distinguish individuals of these two species apart if the locality of origin were not known; though doubtless a sample consisting of a number of individuals could be so distinguished. The habits are similar to those of the Lough Neagh Pollan, both species living chiefly on the small crustacea which abound in these lakes. This Pollan is also caught with nets and exported to the English markets.

The Shannon Pollan (*Coregonus elegans*).

This fish is found in the Shannon lakes. It is a rare fish differing from the two preceding species in the small mouth, the maxillary extending a little beyond a vertical line drawn from the anterior margin of the eye. There are from 78 to 92 scales in the lateral line. So far as the writer is aware nothing is known as to its habits and life-history, though they are presumably similar to the other species of Pollan.

The Powan (*Coregonus clupeoides* or *lavaretus*).

The Powan (Plate 103) is found in Lochs Lomond and Esk. Superficially it resembles a herring, and from this resemblance

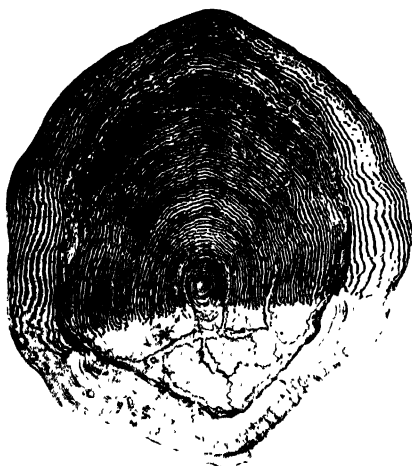


R 242.

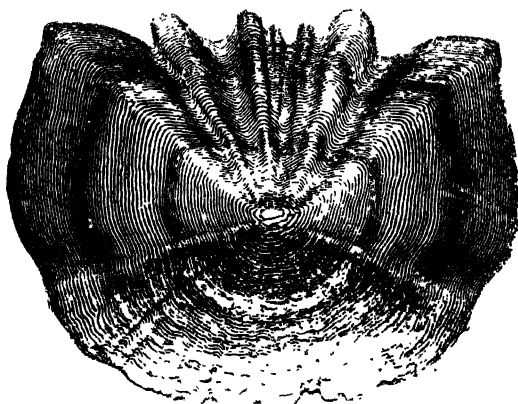
Vendace. (1. 242)
Gwyniad. (p. 242)

1 1/2 100.

A



B



Pl. 101.

R 243.

A. Scale of Wye Salmon, showing spawning mark. (p. 222).

B. Scale of Grayling (p. 245).

it gets its specific name of *clupeoides*. It is sometimes called the Fresh-water Herring. Parnell has described the habits of this fish. They are caught from March to September in large seines, and sometimes with rod and line with an artificial fly. In early morning and late evening large shoals approach the banks of the lake. They disappear in the middle of the day. They are said to be a delicious article of food, and so much esteemed locally that they are rarely sent to distant markets. These fish are of sluggish habits and are said to be strongly scented like the smelt, so much so that their odour may be detected at a distance. Their chief food is small crustacea. They attain a length in Loch Lomond of 18 inches and a weight of 2 lbs.; those in Loch Esk are somewhat smaller.

The Schelly (*Coregonus stigmaticus*).

This fish so closely resembles the preceding species that many authorities regard them as identical. Tate Regan separates them, distinguishing the Schelly by the small blackish spots on the back and sides, by the deeper body and the larger number of branched rays in the anal fin, 10 to 12 in the Schelly and 9 to 11 in the Powan.

The Schelly is found in Haweswater, Ullswater and Red Tarn, all of which drain into the River Eden. It attains a length of 16 inches.

The Gwyniad (*Coregonus pennantii*).

The name Gwyniad is Welsh and equivalent to Whiting. This fish (Plate 100) is an inhabitant of Lake Bala in North Wales. According to Tate Regan, it may be distinguished from the preceding species by its larger eye, by the 9 or 10 (rarely 8) longitudinal series of scales on each side between the

lateral line and the base of the pelvic, while in the Powan and Schelly the number is 7 to 9, the latter number being rare.

The Houting (*Coregonus oxyrhynchus*).

The Houting (Plate 104) is a marine fish of migratory habits belonging to a group of fish popularly known as "Whitefish." Of migratory habits it spawns in fresh water. A fish of striking appearance, the Houting is easily recognised by its projecting, pointed snout. In the summer months it is found in the south-eastern part of the North Sea up to the Dutch coast. Occasionally stragglers venture as far as the Skagerak or Cattegat, or even into the Baltic. The life-history and habits of the Houting are not well known. It appears to live near the coast and in estuaries, where it feeds on molluscs and worms, stirring up its food from the bottom with its long pointed snout. Occasionally it devours small fish, fish eggs and crustacea. In the autumn it migrates to the rivers, but does not go as far up as the Salmon, though it is said to ascend the Rhine as far as Strasburg. It swims in shoals, and from October to December the female lays about 50,000 medium-sized eggs on suitable sandbanks. The Houting, both male and female, show at this time secondary sexual characters in the form of milk-white rows of tubercles, two above and three below the lateral line. There are also tubercles on the scales of the lateral line, though these are not so conspicuous.

The Houting attains a length of 16 inches. Its flesh is esteemed as an article of food; on the Continent it is either sold in a fresh condition or smoked. It is not infrequently seen on the London market. On the Continent the Houting is artificially hatched and reared, more particularly in ponds and pools of good depth. The growth is rapid, the fish attaining a weight of five ounces in its first summer. The cultivation has, however, never attained the importance of that of the Carps and Salmonidæ.

The fishing for Houting along the coast and in the estuaries appears to be of much less importance than in former years. Day gives three records of the capture of the Houting in British waters—from Lincolnshire, the Medway and Chichester. Since then several have been captured in the Colne.

The Grayling (*Thymallus vulgaris*).

The genus *Thymallus*, to which the Grayling (Plate 120) belongs, is distinguished by the long dorsal fin with from seventeen to twenty-five rays, the first four to ten of which are unbranched. This fin in the Grayling is beautifully coloured. The body is elongate, the mouth sub-terminal, rather large, with the jaws provided with a single row of small pointed teeth. There are also teeth on the anterior part of the vomer and the palatines. The body is characterised by an iridescent greenish-gold sheen. Although the colour varies a lot, the Grayling is one of our most beautiful fresh-water fish. Frequently the back is coloured greenish-brown or purple, with silvery grey on the sides and a white belly. There are dark longitudinal zig-zag stripes which mark the limits between the rows of scales, and small scattered dark spots are often present. The name is derived from the greyish colour.

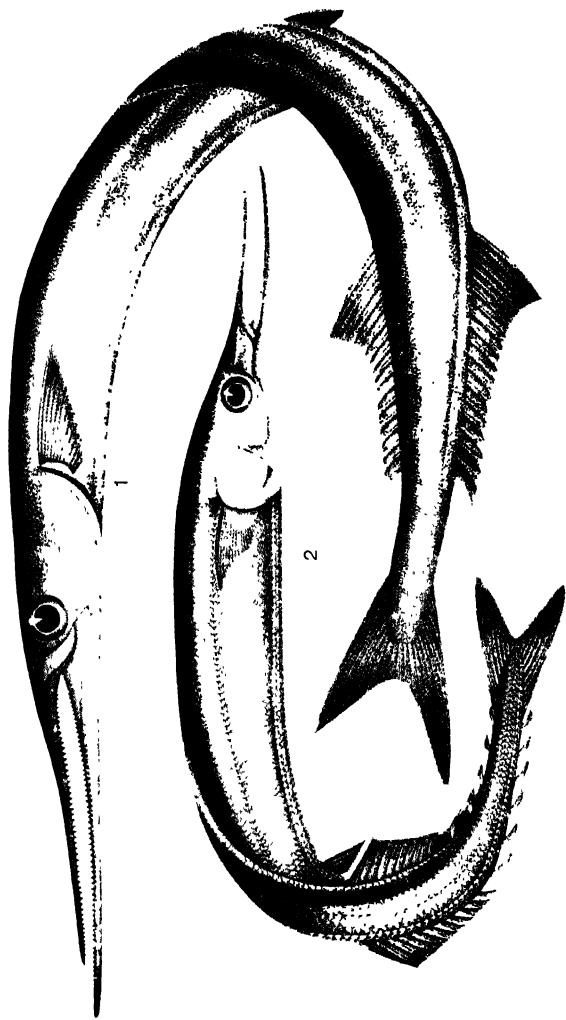
The Grayling is found in Lapland, Finland, and Northern Europe generally, also in Switzerland and the Alpine districts of Middle Europe. It is only found in certain localities; whenever present it is usually found in abundance. In Great Britain the Grayling occurs in the north and midland counties of England, but is absent from Ireland. As in the Salmon, the age of the Grayling can be readily determined by inspection of the scales, which show annual rings of growth (Plate 101).

Grayling and Trout are often found together in the same river. The Grayling prefers swift-running streams with plenty of water and a stony or rocky bottom, with slightly higher temperature than some trout streams.

It is common in Swedish fiords. Generally speaking, the Grayling is a more migratory fish than the Trout. In warm weather shoals may be seen in shallow swift-running water near the river-bank.

The Grayling is a spring spawner. The female lays from 5,000 to 6,000 eggs, not quite as large as peas, from March to May on a gravel bottom in shallow water. The young hatch out in a few weeks. The food of the Grayling consists of crustacea, molluscs and insect larvæ. The Grayling is esteemed for two reasons. In the first place it is a fine sporting fish, and secondly its flesh is of a delicate flavour, by many considered to be superior to that of the Trout. Not only so, its flesh is best in autumn when Trout are not in season. Its artificial cultivation has been attempted on the Continent, but not with any great success. Like all fish which are subject to artificial cultivation, the Grayling is found in a degenerate or dwarf race (Plate 107).

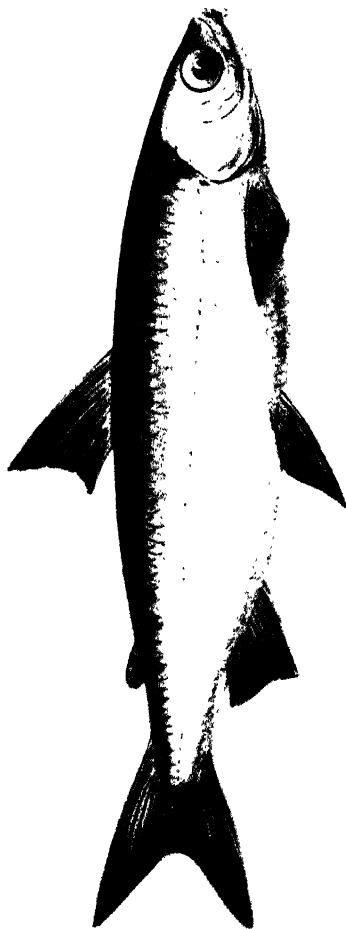
The record for this species caught by fair angling in the British Isles is 4 lbs. 9 ozs. A fish of this weight was caught in the River Wyly at Bemerton, Wiltshire, by Dr. T. Sanctuary, October 24, 1883. One of $4\frac{1}{2}$ lbs. was caught at Ashford, near Ludlow, by Mr. Robinson in 1842, and Mr. G. R. Bryant caught a Grayling of $4\frac{1}{2}$ lbs. in the Itchen in 1898. The most remarkable take of Grayling on record is that of Lt.-Col. J. Croker. Fishing at Horsebridge on the Test in August, 1896, he had one of 4 lbs. 2 ozs. and three others all over 4 lbs. each. Mr. T. L. Parker took three in the River Avon at Ringwood which together weighed 12 lbs., and Mr. H. J. Mordaunt and Mr. M. Headlam had three just over 4 lbs. each on the Test at Mottisfont in December, 1905. The heaviest Grayling on record, referred to by various authorities, was found dead in a weir trap on the Camlet, near Shrewsbury; it weighed 5 lbs.



Pl. 102.

1. Garfish. (p. 246).

2. Saury Pike. (p. 246).



K' 247.

Powan. (p. 242).
Pollan. (p. 241.)

The Smelt or Sparling (*Osmerus eperlanus*).

The body of the Smelt (Plate 92) is fusiform, compressed, and elongate. It is an anadromous species migrating from the sea to the estuaries for spawning purposes. This migration takes place in the Conway from February to April.

The Smelt ranges from the Seine to the Baltic. Its food consists chiefly of small fish and crustacea. Spawning takes place in the brackish waters of estuaries, in the Elbe below Hamburg. The season lasts from March to May, when the fish are closely crowded together in a narrow stretch of water; in British rivers such as the Conway, Leven and Forth near the upper limits of tidal waters. The eggs, light yellow in colour, are heavy and adhesive. The egg membrane is composed of two layers, and the outer layer breaks at one part of the surface of the egg and separates, turning inside out as it does so, remaining attached at one small circular patch. This separated membrane is adhesive, and by it the eggs are suspended to stones, piles and so on. Development lasts from 8 to 27 days according to the temperature. The newly hatched larvæ are 5-6 millimetres long, are very transparent and have the intestine extended beyond the yolk-sac.

The Smelt is a valuable food fish, the odour of the freshly caught fish strongly resembling that of cucumbers. During the spawning season it is confined within very narrow limits, and is therefore susceptible to over-fishing. Moreover, it passes its first summer and winter in or near the estuary of its birth, so that in England and Wales the fishery is regulated both by a close season and by the prohibition of the use of nets having a mesh less than a certain size, usually one inch from knot to knot.

The Argentines (*Argentina silus* and *A. sphyræna*).

The Argentines are deep-water members of the Salmon family, two of which are found in British waters. In these fish the typical second dorsal adipose fin of the Salmonidæ is present, and this, together with the large eyes and scales, serves to distinguish them. The dorsal fin is short and in advance of the pelvics; the caudal is deeply forked. Day records one species only (*Argentina sphyræna*, Plate 26) as British, and for this species he gives only half a dozen records from British waters. This Argentine is now caught in considerable numbers by our west-coast steam trawlers in deep water off the west and south-west of Ireland, and appears with fair regularity in the markets in the great industrial centres in the North of England. The writer has frequently seen it for sale on hawkers' barrows in Preston.

Argentina sphyræna and *A. silus* are similar in general appearance; the easiest means of identifying them is by the fin-ray and scale formulæ, which are for—

A. sphyræna: D. 9-11/0, P. 13-14, V. 11, A. 12-13, L.l. 50-53.

A. silus: D. 11-12/0, P. 17-18, V. 12-13, A. 14, L.l. 60-65.

Argentina silus, which is the larger of the two, frequents the open Atlantic in depths from 80 to 600 fathoms. It has been recorded from British waters by Holt (1897), who obtained a specimen 16½ inches long, weighing 1 lb. 5 ounces, 75 miles true south of the Old Head of Kinsale in 74 fathoms, and Fulton (1901 and 1902), and is found on the American coast as well. A northern species, it seems to be more abundant off the Norwegian coast, Iceland and the Faroes than elsewhere. Spawning takes place from June to September, although the eggs have been taken as early as February. The eggs are floating, but are only met with a good distance below the surface, about 350 fathoms deep. They are transparent and

for floating eggs are large, measuring from 3.0 to 3.5 millimetres in diameter, with a colourless or light red oil-globule. The smaller species, *Argentina sphyraena*, has a rather more southern distribution and lives in less deep water than the larger species, and consequently is found oftener in inshore waters. Since Day's time it has been recorded by Fulton (1901). Spawning takes place in spring in the northern part of the North Sea. The eggs have been described by Ehrenbaum, who caught them in the North Sea off the eastern edge of the Viking Bank in April. They are much smaller than those of *A. silus*, measuring from 1.70 to 1.85 millimetres, and are, like those of the larger species, clear and provided with an oil-globule. They are also bathypelagic, that is, found floating at intermediate depths and not at or near the surface. In June, 1928, thirty-five specimens of *A. silus* were taken 240 miles from Buchan Ness in 80 fathoms. Two specimens of *A. sphyraena* were taken at the same time. Other specimens of *A. silus* were captured 210 miles from Buchan Ness in 70-80 fathoms (Stephen).

SCOMBRESOCIDÆ.

The Garfish or Garpike (*Rhamphistoma belone*).

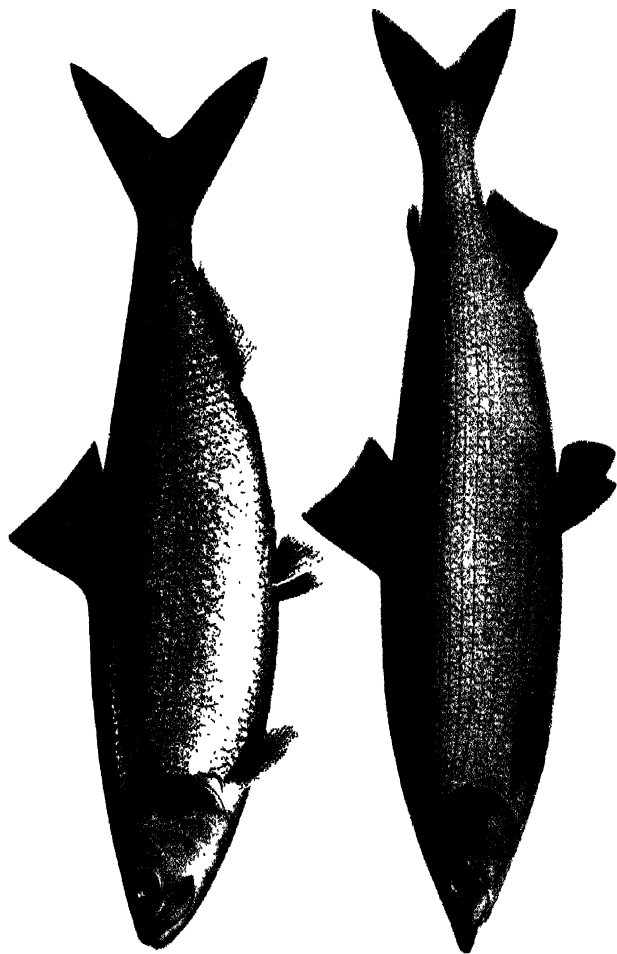
The Garfish, Garpike or Greenbone is easily distinguished from all other British fishes because both jaws are prolonged into a long slender beak (Plate 102), and all the dorsal and anal rays are connected by a membrane. Both jaws are furnished with asperities and are provided with long slender teeth set wide apart.

Garfish approach the west coast of England in the early summer at the same time as the mackerel shoals. The bones of this fish are green in colour. The Garfish egg resembles

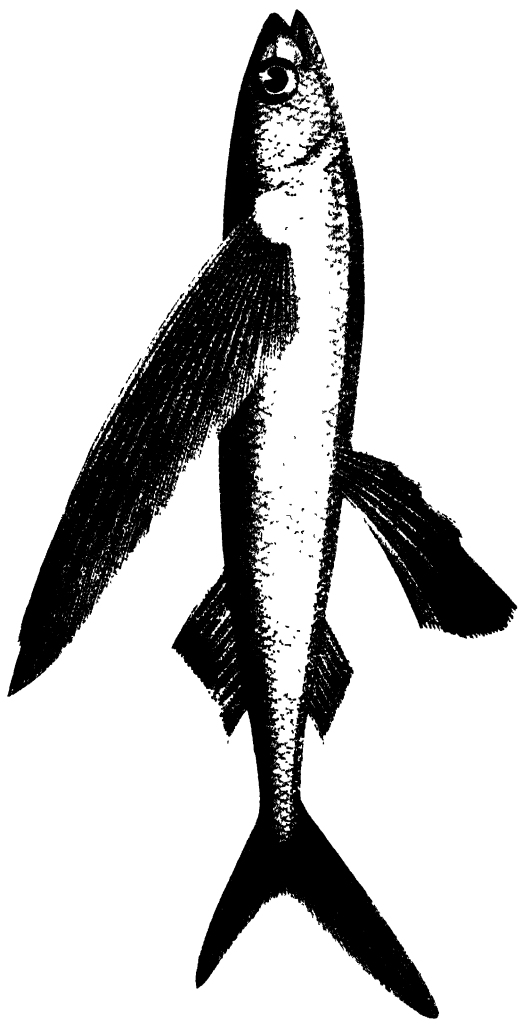
that of the Smelt in that the membrane is provided with adhesive filaments. These in the Garfish are long and slender and serve to attach the eggs to objects on the bottom (Plate 35). The Garfish spawns in shallow water in spring and early summer, from April to June. The eggs, which are from 3 to $3\frac{1}{2}$ millimetres in diameter, are usually deposited on seaweeds. The period of incubation is about five weeks, the larvæ being 1·3 centimetres long when hatched. They are relatively well advanced in development the adult fins being mapped out and the lower jaw prominent. The yolk is almost completely absorbed. The young remain inshore during the first summer, and at this time they pass through an interesting metamorphosis. The lower jaw begins to elongate first, so that the young fish resemble another genus (*Hemirhamphus*) in which only the lower jaw is prolonged. *Hemirhamphus* is not found in the British Isles. I have taken it in fresh water in Bengal. When the young Garfish attains a length of 6 centimetres the upper jaw commences to elongate. At the end of the first summer the young Garfish migrates out to sea, congregating into shoals for this purpose. In summer they again approach the coast, and these coastal and seaward migrations in summer and winter continue through life. The approach of the Garfish to the Welsh coast in summer is accomplished with remarkable regularity.

The Saury Pike (*Scombresox saurus*).

The Saury Pike, or Skipper (Plate 102), resembles the Garfish in having the jaws prolonged into a beak, which, however, is relatively not so long in the Saury Pike. The teeth in this species are minute, while in the Garfish they are of an appreciable size. Posterior to the dorsal and anal fins there are detached finlets in the Saury Pike; these are absent in the Garfish. The Skipper is a pelagic species of gregarious habits ranging from



Twaiie Shad. (p. 267).
Houting. (p. 244).



Pl. 105.

Flying Fish, (p. 251).

R. 251.

the Mediterranean northwards to Norway. They migrate inshore like the Garfish, and every summer shoals approach the entrance to the Channel and the coasts of Cornwall. Spawning takes place in the open sea near the surface. The eggs, which are pelagic, are provided with filaments. The young are widely distributed in the tropical Atlantic. When first hatched the jaws are not prolonged; this prolongation appears as the young fish develop, the lower jaw being the first to extend. The Saury Pike is rarely taken off the west coast, but one was captured off the Smalls Lighthouse by the Fleetwood steam trawler *Gelsina* in August, 1924. Meek records one from Beadnell in November, 1901, and another from the north-east coast in January, 1908. Shoals appeared in the Firth of Forth in 1933, and the fish was also recorded for the first time from the Isle-of-Man and Scarborough.

The Flying-fish (*Exocoetus*).

Flying-fish (Plate 105) are surface-living, gregarious species of tropical waters, from which many species have been described. Of these two are occasionally found in British waters. The chief peculiarity of these fish is that the pectoral fin is enormously enlarged, so that the fish are enabled to make short flights through the air. The fish springs out of the water through the powerful movements of its tail, which give the necessary impetus to the flight. The extended pectoral fins then enable the fish to support itself in the air in the manner of an aeroplane, and when the initial force is expended the fish drops back into the water. The velocity of flight considerably exceeds the speed of a vessel travelling 10 knots, and a distance of 500 feet may be covered in an individual flight. It is perhaps hardly necessary to state that the flying-fish does not leave the water to seek

insects for food, but to escape temporarily from a pursuing enemy. Any deviation from the original direction is impossible, but the fish may rise or fall according to the pressure of the air or wind, and in this manner they appear to leap on to a vessel's deck. Of the two British species, *Exocætus volitans* is fairly common in the Mediterranean and the North Atlantic, and is the larger of the two there met with. It may be distinguished from the other smaller species *Exocætus evolans* by the greater proportionate length of the caudal fin, which in *Exocætus volitans* is more than half longer than the head, and in *Exocætus evolans* is only half the length of the head. Both species produce eggs provided with filaments, and these eggs are almost certainly pelagic. The number of certain records given by Day for the occurrence of *Exocætus volitans* on our coasts is about three. Day regarded *Exocætus evolans* as doubtfully belonging to the British Fauna; it is included on the strength of a solitary record by Pennant. Since Day there are records of flying-fish by Murie in the Medway and Swale (1905 and 1906), and by Patterson at Yarmouth (1906).

ESOCIDÆ (Pike Family).

The Pike family consists of fresh-water fish included in one genus. The only species met with in the British Isles is the Common Pike. The body is elongate and covered with small scales. There are no barbels and no adipose fin. The gill opening is very wide. The dorsal fin is situated much farther back than in the Salmon or Herring families, being opposite to the anal fin. The strongest teeth are at the sides of the lower jaw, where they are few, fixed and erect, and well adapted for seizing prey.

The Pike (*Esox lucius*).

The Pike (Plates 95, 108) is widely distributed in the fresh waters of Northern Europe and Asia. It is also found in North America.

It spawns in the early months of the year, from February to May. Only recently it has been determined that it spawns in the sea, on certain reefs in the Baltic off the coast of Sweden. Of the adult pike the youngest spawn first, making their way to shallow water for the purpose. In the brackish water of the Baltic the Pike spawns at a depth of from 1 to 3 fathoms on seaweed. The females are larger than the males, and each female is attended by two or three males. A large number of eggs are deposited. Buckland estimated there were 595,000 eggs in a pike of 32 lbs. weight. The eggs as a rule lie separately on the bottom, sometimes on flooded grasslands. They are only feebly adhesive at first and they soon lose this characteristic, so that they float near the ground like the eggs of the Shads. The young hatch out in a fortnight to three weeks. The larvæ remain in shallow water, often near the surface, until the yolk is absorbed, which takes about ten days. They then begin to make for deeper water in quest of food. The adult pike is greenish in colour, with the lower parts white; with yellow spots or wavy bands on the sides; dorsal, anal and caudal fins with dark spots or stripes.

The Pike has a deserved reputation for ferocity. It leads a solitary life and seems to select a secluded spot over which it exercises control, and which it does not leave for long. Pennell, in his "Book of the Pike," gives numerous anecdotes of the Pike's ferocity and greed. There are well-authenticated cases of the pike devouring salmon of its own size; Smitt relates one in which a pike of 7 or 8 lbs. darted forward and seized a salmon its own size right across the body. A fierce combat followed, but the salmon could not shake off its captor,

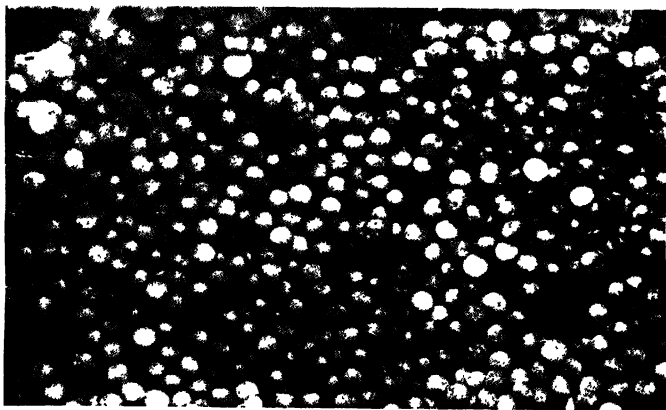
and in a couple of hours was so exhausted that the pike began to swallow it head first. The meal lasted three days before the whole body had disappeared, and for a week after the pike had a swollen appearance and could hardly be made to move by touching it with a long stick.

Pike from 35 to 45 lbs. are by no means uncommon. The question as to who has the honour of the record for the largest pike seems open. Tate Regan figures and describes the great pike of Whittlesea Mere, which was taken when the mere was drained in 1851. The weight is given as 52 lbs., and the total length from the end of the snout to the fork of the caudal fin is 4 feet 4 inches, 13 inches being the length of the head. The probable weight of 72 lbs. is recorded by the same author for the giant pike of Loch Ken in Scotland.

The record for the species caught by fair angling in the British Isles weighed 53 lbs. It was caught by Mr. John Garvin in Lough Conn on July 18, 1920. A number of other big pike up to 45½ lbs. have been caught in Ireland. Two of 37 lbs. have been taken in English waters—one by Mr. A. Jardine at Amersham, Bucks, on September 4, 1879; and the other in the River Wye by Major W. H. Booth in 1911. Stories of monster pike are plentiful, but proofs are not usually in evidence. In the case of the 72-lbs. Loch Ken pike, however, the skeleton of the head is still preserved in Kenmore Castle, and the measurements indicate that the fish could possibly have weighed as much if in good condition. The Whittlesea Mere 52-pounder, taken when the Mere was drained in 1851, seems to be beyond doubt, which is more than can be said regarding other records of pike over 50 lbs. There are authentic records of a good number of pike between 40 and 50 lbs.



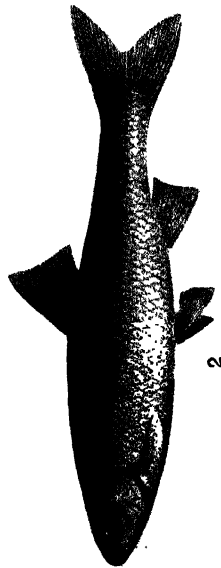
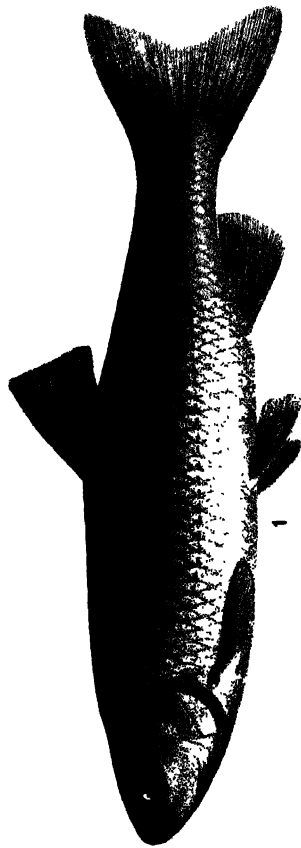
Eggs of Lesser Sand Eel on gravel. (p. 166).



Pl. 106.

Eggs of Herring on Seaweed. (p. 257).

R 254.



THE HERRING FAMILY (Clupeidæ).

Fish devoid of spiny fin rays. A single short dorsal fin placed near the centre of the back, and a short anal fin placed in the hinder part of the body near the tail. The pelvic fins are below the dorsal or a little in front of it. Barbels absent. The body is covered with scales, which are thin and spineless. The mouth is large and the teeth small and weak. Lateral line absent.

There are two British genera, which are distinguished thus :

Upper jaw prominent. Mouth with very deep cleft. Eyes covered by skin. 1. *Engraulis*.

Upper jaw not projecting. Eyes with free lateral adipose lids. 2. *Clupea*.

The first genus contains one species, the Anchovy. The second genus has five British species :

No radiating lines on the gill covers.	{	Pelvic fins behind the commencement of the dorsal. Moderate spines on edge of belly.	Herring (<i>C. harengus</i>).
		Pelvic fins in front of commencement of dorsal. Strong spines on edge of belly.	Sprat (<i>C. sprattus</i>).
Radiating lines on the gill covers.	{	Mouth opening reaches to anterior end of eye.	Pilchard (<i>C. pilchardus</i>).
		Mouth opening reaches to posterior end of the eye.	
		Gillrakers numerous, 60-120 on first branchial arch.	Allis Shad (<i>C. alosa</i>).
		Gillrakers few, 20-45 on first branchial arch.	
		Row of dark spots alongside from head to point beyond dorsal fin.	Twaite Shad (<i>C. finta</i>).

The Herring (*Clupea harengus*).

Most fishermen believe that the Herring (Plate 109) performs seasonal migrations of vast extent. The old idea was of annual migration from Arctic waters southward along our east and west coasts, and this was held to be the reason why the fishery is later the farther south one goes. It is much later, for instance, at Yarmouth than at Thurso or Wick. It is improbable that the herring of Yarmouth belong to the same shoals as those of Thurso or Wick, since the fish are found to be spawning at widely different seasons of the year. According to Pennant, "The great winter rendezvous of the herring is within the Arctic circle; there they continue for many months in order to recruit themselves after the fatigue of spawning." After describing the separation of the shoals into the eastern and western "Brigades," Pennant goes on to say: "Were we inclined to consider this partial migration of the herring in a moral light, we might reflect with veneration and awe on the mighty Power which originally impressed on this most useful body of His creatures, the instinct that directs and points out the course, that blesses and enriches these islands, which causes them at certain and invariable times to quit the vast polar deeps and offer themselves to our expecting fleets. That benevolent Being has never, from the earliest records, been once known to withdraw this blessing from the whole, though he often thinks proper to deny it to particulars; yet this partial failure (for which we see no natural reason) should fill us with the most exalted and grateful sense of his Providence, for impressing so invariable and general an instinct in these fish towards a southward migration, when the whole is to be benefited, and to withdraw it only when a minute part is to suffer."

Although much time has been devoted to the investigation of the habits and life-history of the Herring since Pennant wrote

the above, there is still much that is obscure in the movements of the shoals of this the most abundant and valuable of our food fish.

The egg and young and some of the spawning grounds are well known ; and, as will have been gathered from the preceding pages, the Herring is remarkable in that it is practically the only commercial species of bony marine fish which has demersal eggs, that is, eggs which are laid on the bottom or on seaweed and there undergo their development (Plate 106). Even the other members of the Herring family, such as the Sprat and Pilchard, have pelagic eggs. The egg of the Herring varies from 0.92 to 1 millimetre in diameter, and the average number of eggs carried by an adult female is about 30,000. This is quite a moderate number for a marine fish, and is far below that produced by most pelagic egg-producing species. In most districts where herring abound there is evidence of two main spawning seasons, one in the spring and the other in autumn, and this fact has given rise to the theory that there are two main races of the fish, spring- and autumn-spawning herring.

The development of the Herring does not present any exceptional features, and since it is described in some detail in the works of Cunningham and McIntosh, further reference to it is omitted here. The best summary of our knowledge of the rate of growth of the Herring is contained in a paper by Fulton published by the Scottish Fishery Board.

According to Fulton the Herring grows very slowly, and the investigators who supposed that it reaches the mature condition in a year or eighteen months are much mistaken. At the end of the year in which it was hatched the spring herring rarely exceeds a length of 2 inches, and the great majority are much smaller ; at the same period the autumn herring may be a little over $\frac{1}{2}$ an inch, and is rarely over $1\frac{1}{8}$ inches.

This difference between the spring and autumn herring

persists throughout. Growth in length is somewhat more rapid in the early stages, diminishing with age, at first slowly, and on the occurrence of sexual maturity with great and marked rapidity. Herring, both male and female, appear to attain the mature condition and to reproduce for the first time when the age is from four to five years. The elucidation of the question of the growth of the Herring has an important bearing on fishery problems. Compared with demersal fish, the Herring caught by drift-nets has a great advantage in the struggle for existence, since three or four generations of immature herrings escape through the meshes. In a trawl these fish would be captured.

The spawning grounds and spawning habits of the Herring are now fairly well known. There are different theories as to the intervals between the successive spawning times of the Herring. Heincke is of opinion that the spawn has never been found twice in the same year on the same spawning ground, which would be the case if the same herring spawned twice annually. Cunningham directly contradicts this, since he says that two spawnings have been definitely observed in the same neighbourhood. Matthews also believes that the herring spawns twice in the same year. He believes that the herring spawning off Ballantrae in February and March, and those which spawn off Campbelltown in spring, and then enter Loch Fyne in the summer as spent herring, become ripe there and spawn for the second time from August to the end of October. If this view be correct there would be no distinction between spring-spawning and autumn-spawning races, at any rate of this part of the coast of Scotland.

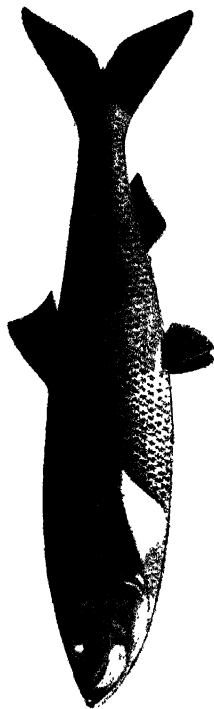
Another theory has been held as to the interval between successive spawning periods. The Scandinavian and Danish writers believe that a period of eighteen months elapses between the spawning periods, in which case the spring herring of one year would become the autumn herring of the next, and so on.



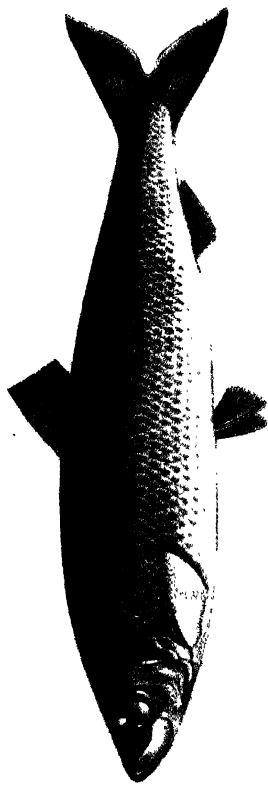
Pl. 103.

Pike. (p. 213).
Sturgeon. (p. 305).

S. 233.



Strömling.



Pl. 109.

Coastal Herring (Baltic),
Varieties or Races of Herring.

S. 259.

Heincke contests this view. He argues that if the interval between two successive spawning periods exceeded one year, then we should get an equal distribution of spawning herring in all months of the year. This argument loses much of its force if the interval were approximately eighteen months, since there would then be two principal spawning periods, spring and autumn.

Since the capture of the mature herring is the occasion of an enormous fishery, we possess a great deal of information as to the appearance of the mature fish on our coasts. It is, therefore, a matter for some surprise that the spawning grounds are not well known and have not been determined with any exactitude. In certain cases limited areas have been explored, the eggs of the Herring collected and the development of the young studied. The first investigation of this kind was that undertaken by Allman, who was deputed by the Scottish Fishery Board to investigate the Herring of the Firth of Forth. He found the spawn of the Herring on rough rocky ground near the Isle of May, at depths from 14 to 20 fathoms. These eggs were attached to stones, shingle, shells and other objects on the sea bottom. Since then the spawn of the Herring has been obtained from other localities, notably from the Ballantrae Bank in the Firth of Clyde, where large numbers of herring eggs have been dredged up from a gravelly bottom in comparatively shallow water. A still more striking instance is that of the Baltic herring which spawn off the Danish island of Langeland in depths of from 1 to 4 fathoms, or even enter the mouth of the River Schlei, where the writer has observed them spawning in brackish water at depths of only a few feet. The eggs of the Herring have been collected in this locality attached to the submerged portions of a fresh-water plant (*Potamogeton pectinatus*). It is a remarkable fact that the Herring can maintain itself in arms of the sea which have been permanently shut off from the main

ocean, and in which the water has become practically fresh. The author has verified this personally in a fresh-water lake (Windeby Noor) in Schleswig-Holstein.

The question of races of Herring is one of great interest, being still the subject of investigation. Heincke has carried out a most laborious and painstaking investigation of the body differences of various samples of herring obtained from most of the fishing grounds of Northern Europe, and as a result he announced that he was able to distinguish two main groups of herring, namely, Spring or Coastal Herring and Autumn or Sea Herring (Plate 109).

Not only did Heincke claim to be able to distinguish these two main races, but he also stated that he had proved the possibility of separating a larger number of local groups, each with its distinguishing characters. According to this view a race of Herring frequents a particular spawning ground, returning there every year to spawn.

The great herring fisheries of North-Western Europe fall into groups or sections, the catch of each of which is dependent on the presence of shoals of a specified race of Herring.

The great Scottish fishery, by far the most important, is concerned with the capture of a race of Sea or Autumn Herring. This herring first appears off the Shetlands in enormous shoals in early summer, and in May and June there is a great fishery off those islands, formerly almost exclusively on the west coast, but now mainly on the east side of the Shetlands. Later in the year and commencing in July, the fishery is carried on at the Orkneys and Shetlands, at Aberdeen, Peterhead, Fraserburgh, and Wick. These fisheries last for some weeks, and are for fish which are nearly ripe or quite ripe, or even actually spawning.

The great English drift-net fishery for herring, which is also participated in by Scottish boats and fishermen, is also for a Sea Herring, and is practically confined to the East Coast,

following the great Scottish fishery. This East Coast fishery commences in May at North Shields, and increases in June, July and August, when Grimsby, Hull and Scarborough commence operations. At the first of these three ports the maximum catch is obtained in September. In this month the landings at Yarmouth and Lowestoft begin, reaching their maximum in October and November.

The coastal race or Spring Herring form the bulk of the catch of the great Norwegian herring fishery. This is the so-called "Vaarsild," a very large herring from 12 to 14½ inches long. The Baltic Herring is also a coastal or Spring Herring.

The Sprat (*Clupea sprattus*).

The Sprat (Plate 117) is not, as many people still think, a young stage of the Herring. It is a distinct species, and may be distinguished from herring of the same size by the following features: The body in the Sprat is much broader than in the Herring, the belly has a sharp keel with strong spines, and the pelvic fins commence in front of the origin of the dorsal. In the Sprat the pelvic fin has usually seven rays, in the Herring there are usually nine. The Herring has an ovate patch of very small teeth in the roof of the mouth of the vomer; there are no vomerine teeth in the Sprat.

The Sprat is a northern fish. It is found all round the British Isles, being very abundant in certain places, such as Morecambe Bay, the estuary of the Thames, the Firth of Forth and Firth of Tay, where it is subject to a regular fishery chiefly carried on in the autumn months. It extends in the North Sea as far north as Norway, where there is an important fishery for it. Formerly it was extensively canned in Norway, the product being sold under the name of sardine with some qualifying term, of which "Skipper" is perhaps the best known. So rapid was the growth of the trade in these canned Norwegian

sprats that the very existence of the French sardine trade was threatened. The French packers took legal action, with the result that these Norwegian fish may no longer be sold under the designation "sardine."

Spawning begins in January in the Channel, and lasts until June or July. The Sprat produces a pelagic egg, this differing markedly from its near relative the Herring.

The Pilchard or Sardine (*Clupea pilchardus*).

The name Sardine is French in origin, and is applied to the young of the same species of fish which when caught by British fishermen, mainly off the Cornish coast, is called by them the Pilchard. A simple way of distinguishing the Herring, Pilchard (Plate 117) and Sprat is to hang them by the dorsal fin. In the Herring the commencement of this fin is midway between the snout and the base of the tail fin; in the Pilchard (and Sardine) it is nearer the snout; and in the Sprat nearer the tail. Consequently when suspended by the dorsal fin the Herring is evenly balanced, the Pilchard hangs with the tail lower than the head, and the Sprat with the head lower than the tail. The Pilchard is a southern fish and is rarely found in northern waters. The author has only caught it on one occasion during twenty years' fishing in the Irish Sea. Williamson records one 9 inches long taken in a herring net 27 miles E.S.E. of Aberdeen in 1905. In Cornwall pilchards are caught by drift-nets and seines. In drift-netting the nets are shot at sunset, many nets being fastened end to end. The last one shot is attached by a rope to the bow of the boat, which thus rides to her nets all night. The boat and nets drift together with the tide. The seines used for pilchards are very long; usually two are used, the principal net being 200 fathoms and the second net 100 fathoms. The greater part of the catch is salted for the Italian market.

The eggs of the Pilchard number 60,000. Since the Pilchard spawns from 20 to 40 miles out at sea, and the fishery is carried on close to the shore, the capture of the mature spawning fish is a rarity. The eggs of the Pilchard are of the pelagic or buoyant kind. They are easily distinguished by three characteristics which, taken together, are peculiar to the Pilchard egg alone. These are the unusually large space between the egg-membrane and the enclosed egg, the complete division of the yolk into a number of irregular segments and the presence of a single large oil-globule in the yolk. The young fish hatch out in three days at a temperature of 62° F. The larva is slightly over $\frac{3}{20}$ inch in length.

The Allis Shad (*Clupea alosa*).

The shads are anadromous fish of North Atlantic distribution. The American Shad (*C. sapidissima*) is one of the most important food fishes of the United States. It was originally confined to the Atlantic coast and rivers, but has been successfully introduced into the Pacific waters. Its eggs are hatched annually by the million in the States. In India a species of Shad (*C. ilisha*), the Hilsa, is the cause of a regular fishery in the Sunderbans and the Ganges, and is a much-esteemed food fish.

In Great Britain the Shad (Plate 110) is a fish of comparative rarity, though possibly at one time much more common. It spawns in the Severn and Shannon, and used to spawn in the Thames. It ascends rivers for spawning purposes much farther than its near relative the Twaite Shad. On the west coast of England a few specimens are taken annually in many of the rivers, but it is doubtful whether there are now any regular spawning beds. The pollution of most of these rivers has driven the Shad away almost entirely, and only a few individuals now attempt a passage

through the mass of sewage and industrial filth which accumulates in the estuaries and which to a large extent drifts up and down with the tide. In the Rhine the Allis Shad ascends as far as Basle, and in the Elbe above Dresden; it also penetrates nearly to the source of the Seine and Loire.

The egg is demersal, but only slightly heavier than fresh water.

The Twaite Shad (*Clupea finta*).

This species (Plate 104) resembles the Allis Shad, but may be recognised by a row of large dark spots which extend along the upper half of the side of the body. The gillrakers are also shorter and less numerous than the Allis Shad. In its habits and distribution it closely resembles *C. alosa*.

The Twaite Shad resembles the Smelt in its spawning, which takes place in estuarine brackish water. It enters fresh water later than the Allis Shad, generally from the middle of April to the beginning of June. It spawns only at night, and the fish rush about during the process so as to make a swishing noise in the water. The egg measures about 4 millimetres. The eggs lie on the bottom and are carried up and down by the tide. The larva is very transparent and closely resembles that of the Sprat. They grow rapidly during the summer and migrate to the sea in November. Apparently they do not go far out to sea, since they are met with again the next summer at the mouths of rivers. The Twaite Shad can live and breed in fresh water without going to sea, and it is landlocked in the lakes of Lombardy and southern Switzerland, ascending the rivers in May and June to spawn. It has much the same distribution as the Allis Shad, but is more common in the Mediterranean and Baltic. This species is rarely taken at sea, but on 24 April, 1923, I captured two specimens in an otter trawl on board the Lancashire Fishery Steamer

in Cardigan Bay 5 miles S.W. by S. from St. Tudwall's Island and one 5 miles W.S.W. of Duddon Buoy 14th March, 1935.

A Twaite Shad, 9 inches long, was captured in Killarney Lake on the 31st January, 1912. From this it would appear that the Twaite Shad may pass the winter in the lake. Tate Regan thinks it quite possible that this species may form non-migratory lacustrine colonies as do the Salmon and Smelt, and as the Shad themselves do on the Continent. Meek records one caught 10 miles off the Tyne in February, 1914, and another North Sea record is given by Stephen in 1931.

The Anchovy (*Engraulis encrasicolus*).

The Anchovy (Plate 117) may easily be distinguished from the other British members of the Herring family by the fact that the snout, which is more or less conical, projects beyond the lower jaw. The teeth are small or rudimentary; the mouth has a very deep cleft. The eyes are covered with skin.

The Anchovy is a southern fish, common in the Mediterranean and ranging through the Channel to the southern part of the North Sea and Zuyder Zee. About eighty different species of Anchovy have been described, mainly from the tropics, but only one, *Engraulis encrasicolus*, enters British waters. It is very rare off the West Coast of England. The present writer has taken it once only in the Irish Sea. Two specimens were captured in a shrimp trawl off the mouth of the Dee on the 17th September, 1904. It is occasionally taken in the weirs in the Menai Straits, and its eggs were taken in a tow-net on Lytham Pier in the Ribble Estuary in June, 1896. Uncommon in Scottish waters, it has nevertheless been recorded by Fulton from near Aberdeen in 1901 and 1902, and from Buckhaven in the Firth of Forth in a herring net in January, 1902.

The spawning season in the Zuyder Zee is from May to July, in the Mediterranean from April to September. Large

numbers of eggs have at times been taken in the North Sea, but the chief spawning place of the Anchovy is in the outer part of the Zuyder Zee and the inshore waters of Holland.

The eggs are easily distinguished, since they are the only pelagic eggs of British fish which are oval in shape. The incubation period takes only a few days, the young larvæ when first hatched measuring only 3 millimetres.

The Anchovy is clearly a migratory fish, since it is only caught in the Zuyder Zee during the spawning season from May to July. Afterwards it migrates seawards down the English Channel and out into the Atlantic. The newly hatched fish remain in the Zuyder Zee until the end of the year. They probably do not migrate far but remain in the immediate neighbourhood of the Dutch coast, returning to the Zuyder Zee in the following spring. The next autumn they make a wider migration; on their second return to the Zuyder Zee they mostly spawn. Their life appears to be a short one, since fish with scales showing more than three winter rings are not known. There is a close association between the temperature of the water of the Zuyder Zee and the presence of the Anchovy.

The Anchovy is not eaten fresh but is prepared for the market by salting in small casks. It is extensively used in the preparation of anchovy sauce, but everything that is sold under that name is not necessarily made from the real anchovy.

The celebrated sauce of the Romans, "Garum," was prepared from a variety of salt-water fish, of which the Anchovy appears to have been one of the most important.

THE EEL FAMILY.

The Eels are readily distinguished by the elongated body. There are no pelvic fins. In British species the vertical fins are confluent with the caudal or tail fin. Most fishes of this

family are marine. The Common Eel differs from its relatives in that it passes the greater portion of its life in fresh water. It is, however, born in the sea and returns there to spawn.

There are three British genera, each with one species. They may be most readily distinguished by the following characters :—

Small scales embedded in skin. Teeth small and in bands.

Common Eel (*Anguilla vulgaris*).

Scaleless; eyes large; gill openings large.

Conger Eel (*Conger vulgaris*).

Scaleless; teeth very large and powerful. Gill openings narrow slits.

The Murry (*Muraena helena*).

The Eel (*Anguilla vulgaris*).

The Eel is a fish of wide distribution. It extends from the Mediterranean to the far north of Scandinavia. It is the subject of important fisheries in the Baltic. There is a great variation in the appearance of Eels at different times (Plate 111), and this has led to a number of different popular names being applied to the Eel, and to the creation of a number of distinct species, sub-species and varieties. There is certainly only one species of Common Eel in British waters. In the first place, there is a marked difference in the sizes to which the sexes attain. Female eels grow to much larger sizes than males. Females of 3 feet long are relatively common, and a length of 5 feet and a weight of 15 lbs. have been attained. The male does not often exceed a length of 20 inches. There are two main types of eels: Yellow Eels which are eels in their ordinary living coloration; and Silver Eels, which are eels in their breeding dress. The larger yellow eels often have an excessive development of the jaw-muscles, due to their extreme voracity, and this gives them a characteristic appearance. This is the so-called Broad-nosed Eel or Frog-mouthed Eel (Worcestershire name). These

Frog-mouthed Eels are common in both fresh and salt water, and are almost invariably females. They are commonly taken on lines baited with small fish.

Eels feed chiefly at night; in the day-time they lie hidden in holes or beneath stones. The smaller eels feed on worms and crayfish, but larger eels will eat almost anything, and have been known to devour frogs, water-birds and water-voles. The Eel unquestionably leaves the water at times, and is able to make its way across country from one piece of water to another, travelling across damp grass or soil at night. This is the reason why, though all eels are born in the sea, many land-locked ponds often contain eels, sometimes of large size. In the autumn the larger yellow eels change colour and take on the silvery breeding dress. They also commence at the same time their migration seawards. These are the Sharp-nosed Eels of the fishermen; the Broad-nosed Eel has often been described as a distinct species to this form, and in fact even Gunther describes *Anguilla latirostris* as a distinct species.

The Silver Eels feed little or not at all. The seaward migration begins in the Mediterranean and Adriatic in September. In Sweden they begin to leave the lakes as early as May, but the main movement is not until August. They leave Denmark in September, the East Coast of Great Britain in August and September, the Severn in October and November, and Ireland usually in September and October.

It is only in the twentieth century that the mystery of the spawning of the Eel has been elucidated. It has been known for centuries that young eels—the so-called elvers—moved up the rivers of Western Europe in spring, and that large eels moved down the rivers in autumn. But for a long time these Silver Eels were lost sight of as soon as they got to the sea, and nothing was known of the intermediate stages between the disappearance of the Silver Eels in the sea in autumn and the

arrival of the elvers in the following spring. While this is true of the British Isles, there is in the Baltic a regular fishery for these Silver Eels in the sea, where they are caught by means of baskets. These eels move parallel to the coast outwards through the Sound into the North Sea. Unless the baskets are set with the openings in a certain direction no eels are taken and so the direction of the migration of the eel is known. Under the auspices of the International Council for the Investigation of the sea, certain Danish investigators marked some of these eels with numbered labels in order, if possible, to determine the rate of progress of this seaward migration. The results of these marked-fish experiments proved that in all cases the migration was a seaward one, since in every case the recaptured fish were taken nearer the open sea. The rate of migration was found to be about 15 kilometres (roughly $9\frac{1}{2}$ miles) per day on the average, and that for consecutive periods of from 17 to 30 days. In individual cases the eels moved 367 kilometres (230 miles) in 29 days, up to 1200 kilometres (750 miles) in 93 days. One particular eel was marked and liberated at Tvarminne in Finland on the 15th August, 1905, and recaptured on the east coast of Jutland near Helgenæs on the 16th November in the same year. Adult eels have never been observed to travel from the sea to the rivers. Probably the Eel spawns only once in its lifetime and then dies at sea. No one has ever captured a perfectly ripe female eel, so there can be no doubt that the Eel spawns in the sea and only in the sea.

In the spring enormous swarms of young eels are seen ascending the rivers of Western Europe. These eels have the same external characters and appearance as the adults. Up to recently it was quite unknown in what part of the sea the Eel spawned. There was, in fact, a great gap in our knowledge between the departure of the Silver Eels and the arrival of the elvers. Thanks mainly to the researches of a Danish investigator, E. J. Schmidt, this gap in our knowledge has now been

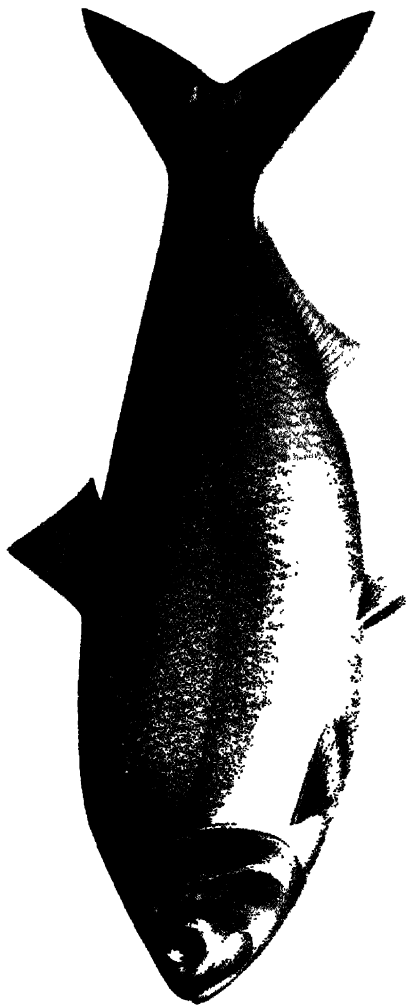
almost completely bridged, though the fertilised egg of the Eel is still unknown. The elver has long been known to develop from a totally different form—the *Leptocephalus*—which was first captured by William Morris near Holyhead in 1763, and described by Gmelin in 1788. Numerous other specimens of this form were subsequently obtained in the Straits of Messina and described under the family name of *Leptocephalidæ*. The *Leptocephalus* is a practically transparent form, and of the



EEL-LARVA OR LEPTOCEPHALUS.

shape of an oleander leaf. Carus first recognised that these *Leptocephali* were larval forms (1861), though he was mistaken in thinking they were larval ribbon-fish (*Trachypteridæ*). In 1869 Gill expressed the view that they were the larvæ of eels, and that a form known as *Leptocephalus morrisii* was nothing but the larva of the Conger.

Gunther accepted this view, but thought they were abnormally developed forms. The French naturalist Delage (1886) succeeded in keeping a specimen of *L. morrisii* in the aquarium of the Roscoff Laboratory alive for seven months and watched its transformation into a young Conger. Previously Kaup (in 1860) had described another form of *Leptocephalus* under the name of *L. brevirostris*, and in 1893 the Italian naturalists—Grassi and Calandruccio—traced the transformation of this form into the young eel or elver. These naturalists were fortunate in finding large numbers of *L. brevirostris* in the Straits of Messina, where strong currents bring them to



Pl. 110.

Allis Shad. (p. 263).

S. 270



Pl. III.

Common Eel. (p. 267)

1. In spawning season (side view).
2. Adolescent state (side view).
3. Adolescent state (back view).
4. Spawning season (back view).

the surface. In other localities these *Leptocephali* occur but seldom, though it seemed unlikely that the Baltic eels went to the Mediterranean to spawn. It was not until 1904 that any *Leptocephali* of the Common Eel were taken outside of the Mediterranean, when Schmidt obtained a specimen west of the Faroe Islands. A second specimen was taken off the west coast of Ireland by Farran, and subsequently numerous larvæ were found in the north-east Atlantic. Schmidt now made a systematic search for these Eel larvæ. He was unsuccessful in the South Atlantic, but eventually found large numbers of Eel larvæ to the west of the British Isles above the 500-fathom line. Why had these larvæ never been found before? Because the Eel seeks great depths in the ocean for spawning purposes (500 fathoms and over). These depths are not found in the Baltic or North Seas. The temperature at 500 fathoms is at least 7° C., a temperature which is not met with in the depths of the North Sea. The great submerged plateau or continental shelf on which the British Isles are situated falls away abruptly into great depths, so that the 100, 500 and 1,000 fathom lines are usually close together. The 500-fathom line varies in its distance from the coast. It is nearest (only 15 miles away) to the coast of the north of Spain.

The larvæ were taken with a fine-meshed mid-water net, and the first large hauls were made off the south-west of Ireland between 56° and 43° N. Latitude. Here the temperature at 500 fathoms is over 9° C. all the year round. Larvæ were obtained right along the 500-fathom line from the Faroes to the north of Spain. These Eel larvæ are true pelagic forms. They are not found on the sea-bottom, but only in the upper layer of water. At night they swim at the surface; in the daytime, at depths from 25 to 50 fathoms. In changing into the young eel the breadth of body of the *Leptocephalus* diminishes, the eyes become a little smaller, the larval teeth disappear and the gut shortens. More recently (1913), Schmidt found

that the Leptocephali increased in number but diminished in size as he went from Europe towards the West Indies. Small sizes were found concentrated in a comparatively narrow area extending from 22° N. to 30° N. Latitude and from 40° to 45° W. Longitude; the central portion lying about Latitude 26° N., or about equidistant from the Leeward Islands and Bermuda. This is the breeding-place of the Eel. At this point the smallest larvæ were found concentrated in considerable numbers.

In his most recent paper (1922) Schmidt has summarised the breeding habits of the Eel. Spawning commences in early spring, lasting on well into the summer. The tiny larvæ, 7-15 millimetres long, float in water-layers about 100 to 150 fathoms from the surface in a temperature of about 20° C. The larvæ grow rapidly during their first months, and in their first summer average about 25 millimetres in length. They now move up into the uppermost water-layers, the great majority being found at 13 and 27 fathoms, or at times even at the surface itself. During their first summer they are found in the West Atlantic, west of 50° W. Longitude. By their second summer they have attained the average length of 50-55 millimetres (2 inches), and the bulk are now in the Central Atlantic. By the third summer they have arrived off the coast banks of Europe and are now full grown, averaging about 3 inches in length but still retaining the compressed leaf-shaped larval form. In the course of the autumn and winter they undergo the retrograde metamorphosis which gives them their shape as eels and brings them to the elver stage, in which they move into the shores and make their way up rivers and watercourses everywhere.

The breeding-grounds of the American eel (*A. rostrata*) lie along the entire range north of the West Indies, with their central portion lying west and south of the central breeding-grounds of the European eel. Therefore the two breeding-grounds overlap and the larvæ of the two species are intermingled in the mid-Atlantic. How comes it, then, that these Leptocephali

separate themselves out and that that of the American eel makes its way to the American coast and that of the European eel migrates across the Atlantic to Europe? Because the pelagic larval stage of the American eel is terminated in about one year, and consequently the larvæ have not time to make the long journey to Europe, the distance being more than they can cover in that period of time. It is otherwise with the European eel, which takes nearly three years to develop, and as a result these larvæ find themselves far away from the American coast, and in the eastern portion of the Atlantic, when the time comes for them, as elvers, to seek the coasts and rivers.

The Conger (*Conger vulgaris*).

The gill openings in the Conger (Plate 112) are large and extend low down to the abdomen. The eyes are large, typical of deep-sea fish. The cleft of the mouth is wide and reaches at least as far as the centre of the eye. The anterior nostril is tubular, the posterior well marked and opposite the middle of the front edge of the eye. The jaws are well provided with teeth, which are in rows in both jaws. In the upper jaw one row of teeth is set so close together as to form a cutting edge. There are no canine teeth, but there is a short band of teeth on the vomer. The dorsal fin commences behind the roof of the pectoral. There are no pelvic fins and no scales.

The Conger is a marine eel of wide distribution, being found in the North and South Atlantic, the Mediterranean, the Indian and Pacific Oceans. It is not found on the west coast of America. It occurs regularly off the Scandinavian coast, is rarer in the central and southern portions of the North Sea, but more abundant in the Channel and off the west coast of the British Isles.

Its life-history is very similar to that of the Common Eel. The fully grown larval stage of the Conger Eel has been known

for many years. It was first recorded at Holyhead by William Morris in 1763, who sent it to Pennant, and was described as a distinct species by Gmelin under the name of *Leptocephalus morrisii*. It has the same bodily shape and general appearance as the larva of the fresh-water Eel (*L. brevirostris*). Specimens have been obtained from the west coast of Scotland and described by Fulton. In 1886, Delage proved that the *Leptocephalus morrisii* changed into a young Conger. The same voyages of the Danish investigating steamer *Thor* which elucidated the mystery of the spawning of the fresh-water Eel were also responsible for clearing up many doubtful points in the life-history of the Conger, though not so many larvæ of the latter were obtained as those of the former. Still, sufficient evidence has been procured to establish beyond doubt that the Conger, like the fresh-water Eel, makes a remarkable migration into deep water for spawning purposes.

Like the Eel the Conger, almost certainly, spawns only once, and dies after the spawning act is completed. Schmidt, the Danish investigator, whose researches into the spawning of the fresh-water Eel have already been referred to in some detail (p. 271), has proved that the congers of Western Europe originate in the deep waters of the Atlantic. While a drift of Conger larvæ enters the Mediterranean, in contrast to the fresh-water Eel, the Conger spawns there as well. The Atlantic spawning-ground of the Conger lies between 30° and 40° N. Latitude, and beyond a depth of 1,600 fathoms. The spawning period is in late summer. In August the American investigation schooner *Grampus* captured some pelagic eggs of 2·4 to 2·75 millimetres diameter which have been referred by Eigenmann, probably correctly, to the Conger. The eggs float in intermediate layers and rarely come to the surface. The early hatched larvæ from these eggs have been described by Eigenmann, but between these early larvæ forms and the *Leptocephalus* stage there is still a great gap in our knowledge.

Leptocephali of the Conger of all degrees of development have been captured in fairly considerable numbers. Schmidt thinks that the metamorphosis in the Conger is a very gradual process, so that the Conger Leptocephali, which come from the same part of the ocean as the Eel larvæ, are already in the neighbourhood of the coast and in quite shallow water before the Leptocephalus stage is completed. At any rate, quite a number of Conger Leptocephali have been found quite near the British coast. On arrival in continental waters the larval teeth are lost and there is a considerable reduction of the body size, from 12 to 7½ centimetres. The body now becomes round and the eel-like form is assumed. Pigmentation sets in, as in the fresh-water Eel, but not to the same extent. The young Conger up to a length of 15 inches remains pale and pinkish in colour, after which it assumes gradually the dark colour of the adult.

It is caught both by trawl and line, especially on or near rocky ground. It is an extraordinarily prolific fish, the number of ova in an adult female ranging from three to eight millions.

The name Conger is derived from the Latin *conger* or *congrus*, meaning a sea-eel. In classical times its flesh was considered a great delicacy.

The Conger attains a considerable size and weight. In the *Illustrated London News* for the 17th September, 1904, is an illustration of a Conger measuring 9 feet and weighing 160 pounds.

The Murry or Muræna (*Muræna helena*).

This species is a southern fish of warm or tropical waters, only occasionally wandering as far as our southern coasts. It is easily distinguished from the Conger by the narrow gill opening, the absence of pectoral fins and the formidable pointed teeth. The body is, moreover, generally covered with irregular

yellow marks or spots. There are poison glands associated with the vomerine teeth, so a bite from this fish may be dangerous.

The writer has never seen this fish in British waters, where it must be considered extremely rare. He has taken murænoids commonly in the trawl in the Bay of Bengal.

This fish was well known to and much esteemed by the ancient Romans, and there are numerous references to it in the classics. Veditius Pollio is alleged to have kept this fish as a pet and to have fed it with the flesh of slaves! There is a fine picture of *Murana helena* in a Pompeian mosaic now in the Naples Museum.

Holt records a specimen 44·6 inches long trawled off the Eddystone in March, 1897; according to him there are only two previous records.

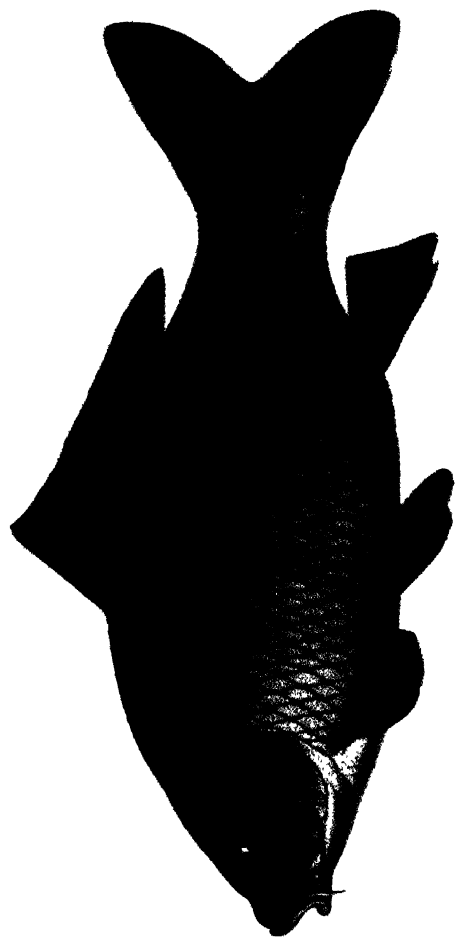
A species of Synphobranchidæ has been described from British waters, namely, a young form ($4\frac{1}{2}$ inches long) of *Synphobranchus pinnatus* by Holt and Byrne from the west coast of Ireland in depths of 450 fathoms. Other British deep-sea eels are described in the Appendix (p. 371).

THE CARP FAMILY (The Cyprinidæ).

This is one of the most important families of the bony fishes. It is predominantly fresh water, and is found widely distributed practically all over the world.

The Carp family is richer in species than any other family of fish, and over a thousand have been described from Europe, Asia, Africa and North America. Many of the European species wander into brackish waters and are found in such waters





Pl. 113.

Common Carp. (p. 282).

T 277.

in the Baltic. The Cyprinidæ are distinguished by the following peculiarities. The head is naked, the body covered with scales. The mouth is toothless, protractile, and the margin of the upper jaw is formed by the intermaxillaries. There is no adipose fin. The most important characteristic of the family is that the lower pharyngeal bones are well developed, falciform, sub-parallel to the bronchial arches, and provided with one, two or three series of teeth. The majority of the Carp family feed on both animal and vegetable substances; a few only are strictly vegetarian in diet. It is strange that the larvæ and young stage of these—the commonest of our fresh-water fish—have not been studied or described with any degree of accuracy, and that really less is known about them than about many of our marine species.

In many respects it will be found that the various species of Carp resemble one another, but even so the number of fin rays and scales afford a ready means of distinguishing the species. Another safe and reliable means of separating the various forms is afforded by the teeth on the lower pharyngeal bones, which bite upwards against a hard plate attached to a posteriorly directed process of the basal part of the skull. The form of these teeth, and especially their number and arrangement into one, two or three rows, is of importance in distinguishing the various forms.

The following table summarises the various arrangements met with. The number refers to the number of teeth in each row, thus 4-4 means four teeth in a single row on each side. The pharyngeal teeth may be arranged—

A. In one row :

<i>Carassius</i> (Crucian Carp)	..	4-4
<i>Carassius</i> (Goldfish)	4-4
<i>Tinca</i> (Tench)	4-5 or 5-4 (rarely 5-5)
<i>Abramis</i> (Bream)	5-5
<i>Leuciscus</i> (Roach)	5-5 or 6-5

B. In two rows :

<i>Leuciscus leuciscus</i> (Dace)	..	2-5	5-2
<i>Leuciscus cephalus</i> (Chub)	..	2-5	5-2
<i>Phoxinus</i> (Minnow)	2-5	4-2
rarely	2-4	4-2
<i>Alburnus</i> (Bleak)	2-5	5-2
<i>Gobio</i> (Gudgeon)	2-5	5-2 or
<i>Blicca</i> (White Bream)	3-5	5-3
<i>Scardinius</i> (Rudd)	3-5	5-3

C. In three rows :

<i>Cyprinus</i> (The Carp)	1-1-3	3-1-1
<i>Barbus</i> (Barbel)	2-3-5	5-3-2

The Carp, like other fish which are artificially propagated, are liable to great variation, so that the numbers given above do not represent the extreme variation that may be met with in any given case. Regard must be had to other characters, such as the number of fin rays and scales, in order to come to a correct conclusion. The form of the pharyngeal teeth varies considerably; they may resemble molars as in the Carp, or they may be long and hook-like as in the Chub. The form of these teeth is not absolutely to be relied on as a guide to the diet of the fish. Some members of the Carp family are predaceous, feeding on the bottom-living water fauna—snails, insects and crustacea; but on the whole their diet is vegetable. The plain and uniform coloration of many carps, which has led to the name “white fish” being given to the sub-family Leuciscina (Roach and allied forms), gives place in the breeding season to a brilliant coloration, especially in the males. The breeding season is in spring and summer, and at this time the males develop small tubercles on the head. In some species these tubercles extend on to the back and sides of the body. There is also a thickening of the first ray of the pectoral fin in the male. Carp as a rule live in shoals of varying size. They prefer quiet,

warmish water with a muddy bottom. In the winter they move into deep water, where they remain in a quiescent condition, some, such as the Tench, even burrowing into the mud.

On the Continent the Carp family form an important part of the fish supply, especially in districts remote from the sea. Their rapid growth and the ease with which they may be bred and reared in confinement account for their wide distribution and general appearance in the markets. It is claimed that the Carp are excellent to the taste, but one may be pardoned for preferring sea fish, most of whom far excel the Carp in this respect.

The members of the Carp family may be separated by the following characteristics :—

Dorsal fin long, 14 to 23 branched raysGroup I.

Dorsal fin short, 13 or less branched rays :

(a) Anal fin short, 13 or less branched rays Group II.

(b) Anal fin long, 15 to 29 branched rays ..Group III.

Group I.

A. Two barbels on each side of mouth. Caudal fin strongly forked. The Carp (*Cyprinus carpio*).

B. No barbels. Caudal fin slightly forked :

1. Dorsal spine feeble, finely serrated. Edge of dorsal fin convex. $6\frac{1}{2}$ to 9 scales between origin of dorsal and lateral line. Crucian Carp (*Carassius vulgaris*)

2. Dorsal spine strong, coarsely serrated. Edge of dorsal fin straight or concave. 5 to $6\frac{1}{2}$ scales between origin of dorsal and lateral line. Goldfish (*Carassius auratus*).

Group II.

A. Mouth with barbels.

Mouth inferior, two barbels on each side. Last simple ray of dorsal fin a serrated spine. Barbel (*Barbus vulgaris*).

Mouth inferior, one barbel on each side. No dorsal spine.

Gudgeon (*Gobio gobio*).

Mouth terminal, a small barbel on each side. Scales small.
Tench (*Tinca vulgaris*).

B. No barbels.

1. Scales small; tubules of lateral line extending whole length of exposed part of scale.

Minnow (*Phoxinus phoxinus*).

2. Scales moderately large; tubules of lateral line not extending to free edge of scale. Free edge of anal fin convex.

Chub (*Leuciscus cephalus*).

Free edge of anal fin concave.

Origin of dorsal above or slightly behind base of pelvic.

Body narrow. Dorsal fin with 7 or 8 branched rays.

Dace (*Leuciscus leuciscus*).

Body moderately deep. Dorsal with 9 to 11 branched rays.

Roach (*Rutilus rutilus*).

Origin of dorsal fin behind base of pelvic.

Rudd (*Scardinius erythrophthalmus*).

Group III.

In this group the abdomen is compressed to a sharp edge over which the scales do not pass.

A. Body deep.

- 44 to 50 scales in lateral line; 8 to 11 between origin of dorsal and lateral line. Dorsal with 8 and anal with 19 to 24 branched rays.

White Bream (*Blicca bjoernka*).

- 49 to 57 scales in lateral line; 11 to 15 between origin of dorsal and lateral line. Dorsal with 9 and anal with 23 to 29 branched rays.

Bream (*Abramis brama*).

B. Body elongate.

Bleak (*Alburnus lucidus*).

In many systematic works dealing with the bony fish a scale and fin-ray "formula" is given. In this volume these formulæ are omitted as being beyond the scope and intention of the book. It is only in extreme cases that the amateur fisherman will rely on scale and fin-ray counts for the determination of species. He will generally find that the

distinguishing characters given in this book are sufficient for the purposes of identification, especially when the illustrations are consulted as well. Moreover, the counting of scales and fin-rays soon proves a weariness to the flesh for the average amateur. It may be said at once that except in rare instances they are unnecessary. In the Carp family, however, where the variation in bodily form is greater than in any other group of bony fish, an occasional scale and fin-ray count is of service in confirming an otherwise doubtful identification, so that an explanation of a typical case is given here.

For the Roach the following (or a similar) formula is given in some works of reference :—

D. 3/8-9, P. 1/15-17, V. 2/8, A. 3/5, C. 19, L.l. 42-45.

L.tr. $7\frac{1}{2}$ - $8\frac{1}{2}$ / $6\frac{1}{2}$.

This rather formidable "formula" refers to the number of unbranched and branched rays in the various fins. Thus D. is the Dorsal, P. the Pectoral, V. the Ventral or Pelvic, A. the Anal and C. the Caudal fin.

The scale "formula" L.l. refers to the number to be counted on the lateral line between the head and the caudal fin, and L.tr., the scales between the origin of the dorsal fin and the lateral line and between the lateral line and the ventral or pelvic fin (page 14). The formula for the Roach may therefore be interpreted thus :

Three unbranched and 8 to 9 branched rays in the dorsal fin, 1 unbranched and 15 to 17 branched rays in the pectoral fin, 2 unbranched and 8 branched rays in the ventral or pelvic fin, 3 unbranched and 5 branched rays in the anal fin, 19 rays in the caudal fin ; scales between the head and caudal fin (L.l.) arranged in from 42 to 45 transverse series, scales between the origin of the dorsal fin or median line of the back and the lateral line (expressed by L.tr.) in from $7\frac{1}{2}$ to $8\frac{1}{2}$ longitudinal series, and between the lateral line and the middle of the abdomen $6\frac{1}{2}$ longitudinal series.

In different species of fish the unbranched ray may be either a simple ray, or a spine or a simple articulated soft ray. The spiny ray may be serrated as in the third dorsal fin-ray of the goldfish.

The Carp (*Cyprinus carpio*).

The Carp (Plate 113) is the most widely distributed of the Cyprinoids. It is easily distinguished from the other members of the Carp family by the four barbels, by the unusually long dorsal fin with from 17 to 22 branched rays and by the strongly serrated third spine of the dorsal and anal fins. Like all other creatures which have been domesticated, the Carp is found in several distinct varieties. The variations are of two main types—in the bodily shape and in the scaly covering. On the Continent, where this fish has been cultivated for centuries, there are well-marked types, such as the Leather Carp, devoid of scales, or the Mirror Carp with the scales much enlarged but confined to one or two rows on each side. These types are really “sports,” and are not restricted to any given locality or found under any given conditions. They frequently throw back to the normal carp form. In addition to the variation in the scales there is a great difference in the shape of the body; in one form the body is elongated, in the other, compressed. According to the Continental fish culturists, these forms can be produced by changes in the food; when the food is meagre in quantity and the fish is starved the elongated form is developed, whereas by intensive feeding the short and deep body is produced.

The Carp is a southern fish; its original home was in the Black Sea, the Caspian and eastwards to Turkestan. From there it has been introduced into Europe and England. It spread rapidly owing to its excellent taste, rapid growth and the ease with which it could be cultivated and kept in confinement. The Carp can be sent for long journeys in a very small volume of water, and will even travel considerable distances alive out

of water if carefully packed in damp moss. In cold water or in mountainous regions it does not flourish. It has been acclimatised in the United States of America, where it has increased in some localities to such an extent as to become a positive nuisance. The time of its introduction into England is unknown—it is now widely spread throughout the country; but all our wild Carp are regarded as descendants of fish which were originally introduced and cultivated by the monks for centuries.

The wild Carp prefers lakes and ponds or slow-moving waters, preferably with a muddy bottom. The young stages are found near the banks, the adults in deeper water. Its diet is partly vegetable and partly animal; worms and insects and their larvæ are eaten, and the fish even takes in mud, which after a time it ejects again. The spawning period is in May and June; in the Continental carp ponds the fish becomes mature in its fourth year. Sexual maturity is indicated in the male by the appearance of white wart-like tubercles on the skin, especially on the head, and these tubercles are also found on the female in the wild condition. The Carp is a prolific fish, yielding about 63,600 eggs for each pound of the body weight. The spawning has frequently been observed. It takes place in shallow water, the female laying masses of eggs on the fronds of water-plants. The young larva hatches out in three or four days. It is remarkable that we have no satisfactory account in English of the eggs and young stages of so common a fish as the Carp. The limit of weight in England is, according to Tate Regan, 25 lbs., but on the Continent the wild Carp attains a weight of over 60 lbs. and a length of 40 inches. Still larger examples have been reared in captivity.

The Carp is a shy fish and is not easy to catch with rod and line. Even when netted it frequently escapes by diving under or jumping over the seine. The celebrated "Mahseer" (*Barbus tor*) of Indian waters is a near relative of the Carp.

The name "Carp" is derived from Low Latin, *carpa*. The name is similar in many languages, for instance, Old French, *carpe*; German, *Karpf*; and Celtic, *Cerpyn*.

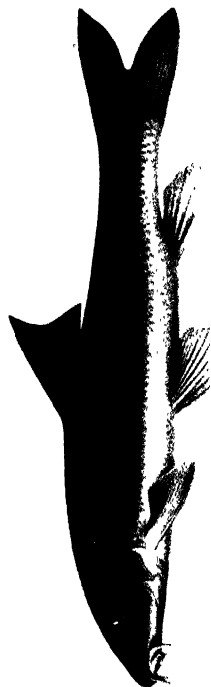
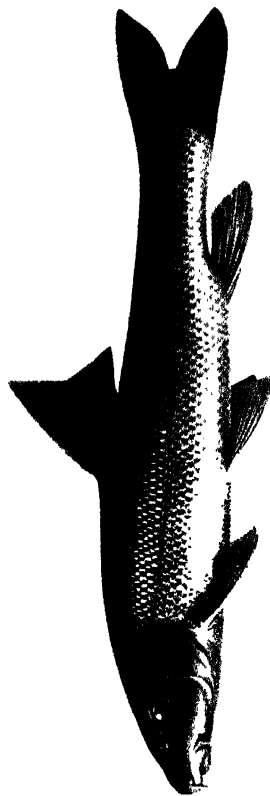
The record for this species caught by fair angling in the British Isles up to the present weighed 20 lbs. 3 ozs. It was caught in the Cheshunt Reservoir by Mr. J. Andrews on the 9th September, 1916. One of 20 lbs. was taken in the River Thames at Wallingford, September 1883; another of 19½ lbs. in the Warren Pond, Chingford, Epping Forest, by Mr. J. T. Fisher, 8th July, 1919. Another the same weight was taken in the Canal at Weybridge by Mr. H. S. Locksmith in 1907. A few carp over 20 lbs. have been captured when lakes have been drained: one of 24½ lbs. was taken in the autumn of 1858 in the Great Pond at Harting, near Petersfield; another of 24 lbs. was taken as recently as December, 1923, from an old pond in the Home Park at Hampton Court.

The Crucian Carp (*Carassius carassius* or *vulgaris*).

The Crucian Carp (Plate 114) may be distinguished from other carps by the fact that, although it has, like the common Carp, a long dorsal fin with from 14 to 21 branched rays, it differs from the latter in having no barbels. Its tail fin is also less forked than that of the common carp.

The Crucian Carp also exhibits considerable variation in form. Like the common Carp it originated from Asia, being introduced into Continental waters in Europe and subsequently into England. It is not so common in England as the ordinary Carp, and is not found at all in Scotland, Wales and Ireland. On the Continent the Crucian Carp in certain lakes attains a length of 15 inches and a weight of 5½ lbs.; but in ponds and pools it may be no more than a fingerling in length. In its habits it closely resembles the common Carp, preferring stagnant water. It is a bottom fish of the shallow-water regions





of ponds and pools, and is one of the hardiest of fish. Not only can it be sent long distances out of water if packed in damp grass, but it will also bury itself in soft mud in the bottom of ponds, so that even if the pond is entirely dried up in summer the fish can survive. The eggs are laid from May to July amongst weeds in shallow water.

Although on the Continent it is less cultivated than the common Carp, it is nevertheless the object of pond culture in Russian Poland as well as in certain parts of Belgium and France. It is a very quick-growing fish, reaching a weight of over 1 lb. in its second year. The name "Crucian" is derived from the German name for this fish, "Karausche."

The Gold-fish (*Carassius auratus*).

The form is considered by some authorities to be merely a variety of the Crucian Carp, but Tate Regan considers it a separate species, distinguished from the Crucian Carp by the fact that the body is more elongate, the dorsal fin highest anteriorly, the spine being strong and coarsely serrated; the scales are large, 25 to 30 in the lateral line (28 to 35 in the Crucian Carp) and 5 to 6½ between the origin of the dorsal fin and the lateral line (6½ to 9 in the Crucian Carp). This species is of Asiatic origin, and in a wild state has the greenish-brown colour of the other carps. It is a hardy species and lives well in confinement. In Italy it is cultivated for ornamental purposes, but in Japan and China the culture reaches its highest "art." The Japanese in particular have bred many remarkable varieties of this fish. There are forms with the dorsal fin reduced or absent, with protruding eyes (demekin), with strawberry-like protuberances on the head, with the caudal fin split into three or four lobes which are in some cases greatly elongated. In one variety, the Ranchu, the head after a few years develops

all over a number of protuberances like the achenia of a strawberry. As this form has a globular body, a short protuberant abdomen and a short caudal fin and no dorsal, it can hardly swim and is usually seen in an erect position with the head downward. A few years ago a number of these interesting varieties were brought to Barrow by officers of the Japanese warships which were then being built there, but they did not long survive in this country, probably owing to unskilful management.

The Barbel (*Barbus barbus* or *fluviatilis*).

The Barbel (Plate 115) resembles the Carp in having four barbels, from the presence of which its name is derived. In the Barbel they are, however, large and of practically equal size. The Barbel differs from the Carp in that its dorsal fin is short with only 8 to 9 branched rays; its last dorsal simple ray is also coarsely serrated. The snout of the Barbel is rather long, and this also serves to distinguish it from the Carp. The colour of the Barbel varies considerably, but in general it is greenish-olive, darkest on the back, with golden reflections on the sides. Small dark brown spots are often present on the back and sides and on the dorsal and caudal fins. It is found in the Danube, Rhine and other rivers of Central Europe. In England it is only abundant in the Thames and Trent. In its distribution and habits it stands between the cold-water Salmonidæ and the warm-water Carps. It avoids both the low sluggish and warm rivers and the mountain brooks and streams, preferring the intermediate stretches of river where on a pebbly bottom it flourishes in a medium temperature and fairly abundant water-supply. In England this fish grows to a length of 3 feet and a weight of 20 lbs., but on the Continent specimens weighing 33 lbs. have been recorded. According to Day a weight of 50 lbs. has been attained by the Barbel in the Rhine and Danube.

The structure of the barbel—its barbels, thick lips, ventral mouth, small eye and long cylindrical body—point to its mode of life. It is a ground fish of deep water, where during day-time it hides, avoiding the light. At twilight it seeks its prey, feeding for the most part on worms, crustacea and insect larvæ. It is a gregarious fish, being found usually in shoals. In winter these shoals consist of large numbers of fish, which at this time seek the deep water, where they remain throughout the winter in a torpid condition.

The Barbel spawns in May and June. As in other carps the males develop tubercles on the head. The spawning fish seek a gravel bottom in fairly deep water. The eggs, which are of a yellow colour, are of the size of millet grains. A female weighing a little over 2 lbs. will produce 9,000 eggs, which when laid are covered over with gravel by the parent fish. The period of incubation is about a fortnight.

The flesh is considered to be of medium quality only. The roe is poisonous and should not be eaten. It is a good sporting fish, being wary, strong and active.

The name "Barbel" is derived from the Latin *Barbellus*, a diminutive of *barba*, a beard.

The record Barbel caught by fair angling in the British Isles weighed 16 lbs., and was caught by Mr. Dodd in the River Lea on 7th July, 1880. In 1888 Mr. T. Wheeler caught one weighing 14 lbs. 6 ozs. in the River Thames at Molesey Lock, and another of 14½ lbs. was caught at Radcot Bridge, on the Thames, by Mr. R. Jones in 1909. A 14-lb. Barbel caught in the River Kennet by Mr. M. H. Lewis was shown at the International Fisheries Exhibition in 1883. Mr. Kelsey had one of 12 lbs. 12 ozs. from the River Kennet in 1894, and also one of 12 lbs. 10 ozs. A 19-lb. Barbel said to have been caught in the River Lea is mentioned by Dr. Day, but no particulars are available.

The Gudgeon (*Gobio gobio*, or *G. fluviatilis*).

The Gudgeon (Plate 116) is a small member of the Carp family with an elongated and rounded body and relatively large head and eyes. The scales are large and the fish possesses two barbels. The species is a variable one, and formerly it was split up into several distinct sub-species based on the length of the snout, the shape of the body and the darker or lighter coloration. The Gudgeon somewhat resembles the Barbel in general appearance, but may be distinguished from it by the fact that while the Barbel is provided with four barbels, the Gudgeon has two only. Moreover, a strong contrast is afforded by the pharyngeal teeth; in the Barbel they are in three series on each side, five in the inner row, three in the middle and two in the outer row; in the Gudgeon there are only two series, four or five in the inner and two or three in the outer on each side.

The Gudgeon is distributed across Europe from England to the rivers of the Caspian Sea, except the Iberian Peninsula and Greece. In England and Wales it is generally distributed, but has not been recorded from the Lake District, West Wales or Cornwall. It is common in Ireland, but absent from Scotland. Gudgeon are found in rivers, brooks, ponds and even in subterranean streams. It is also found, but rarely, in the brackish waters of the Baltic, preferring a sandy or gravel bottom. The Gudgeon is gregarious; large shoals may often be seen on the bottom close to the bank of the river or pond. The Gudgeon is a bottom-living fish, as might in fact be deduced from its structure: the barbels and ventral mouth are characteristic of a bottom form. It spawns in running water in May and June, and deposits eggs which are transparent but with a clear blue or yellowish shimmer. The eggs are adhesive, and a female lays from 1,000 to 3,000 in a season. They lie on the bottom in small clumps; spawning is gradual, a few eggs only being deposited

at one time, and it may last through the summer. The usual period of incubation is 10 days.

The young fish when first hatched has a very large yolk-sac. Very little is known of the larval stages of this species. The Gudgeon is a small species, the average length being 6 inches. In spite of its small size it is considered a good sporting fish. Its flesh is of a delicate flavour, and according to old writers on fish and fishing it was formerly the subject of a regular fishery. It is easily captured with rod and line.

The name "Gudgeon" is derived from the Latin *Gobionem*, the accusative of *Gobio*, a Gudgeon. The French form is *Goujon*.

The Tench (*Tinca tinca* or *vulgaris*).

The Tench (Plate 119) is an easily distinguished species. The two barbels and the numerous small golden-yellow scales, of which there are from 95 to 100 along the lateral line, serve to distinguish it from the other Cyprinoids.

It is found all over Europe, Asia Minor and Western Siberia. In Britain it is found as far north as Loch Lomond.

Its distinguishing features are slothfulness, avoidance of light, and a preference for the bottom. It is only found in still waters and it flourishes in small ponds, especially those with many water-plants and a muddy bottom, passing the winter buried in mud in a torpid condition. It is soon exterminated from ponds by predatory fish like the pike, unless provided with plenty of shelter among water-weeds. In the Baltic it is found in brackish water. It seeks its food by night, capturing small crustacea and insect larvæ amongst the water-plants. The Tench is especially fond of fresh-water molluscs.

The spawning period falls between the months of April and August, and it is one of the latest spawners of British fresh-water fish. The eggs, which are small and numerous, are

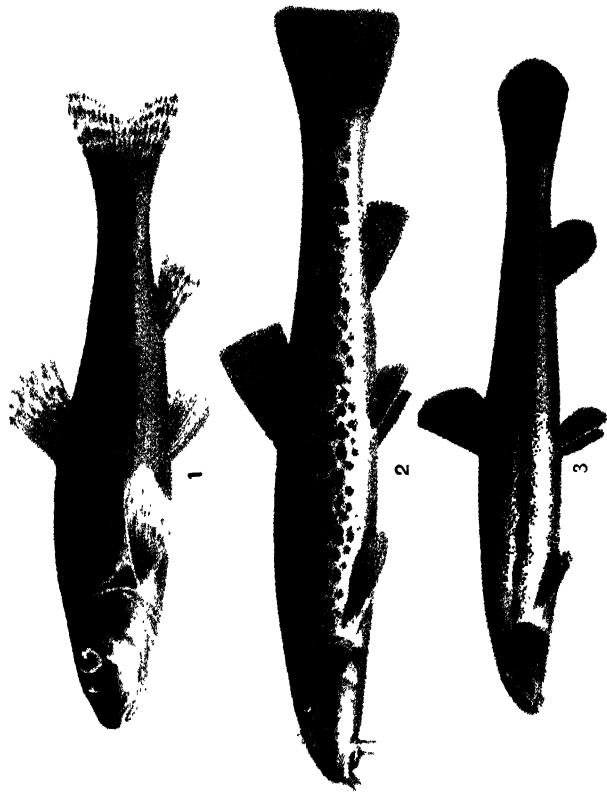
deposited on water-weeds. A female Tench produces about 297,000 eggs. Spawning is not continuous, but takes place gradually with several intervals. The period of incubation is a week. The Tench attains a weight of 8 lbs. in England ; on the Continent it grows to a length of 28 inches and a weight of 17 lbs. Its flesh is white and firm and is usually considered to be superior in flavour to its near allies, the Roach and Dace. It is still cultivated largely on the Continent, where the flesh is highly esteemed, and was doubtless kept by the monks in their stew-ponds in England in former times. A curious belief formerly held with regard to the Tench was that it exercised a curative influence on the wounds of other fish, whence it was called the " doctor fish." It was thought that sick or wounded fish were cured by touching the Tench, the thick slime covering the Tench's body possessing curative properties.

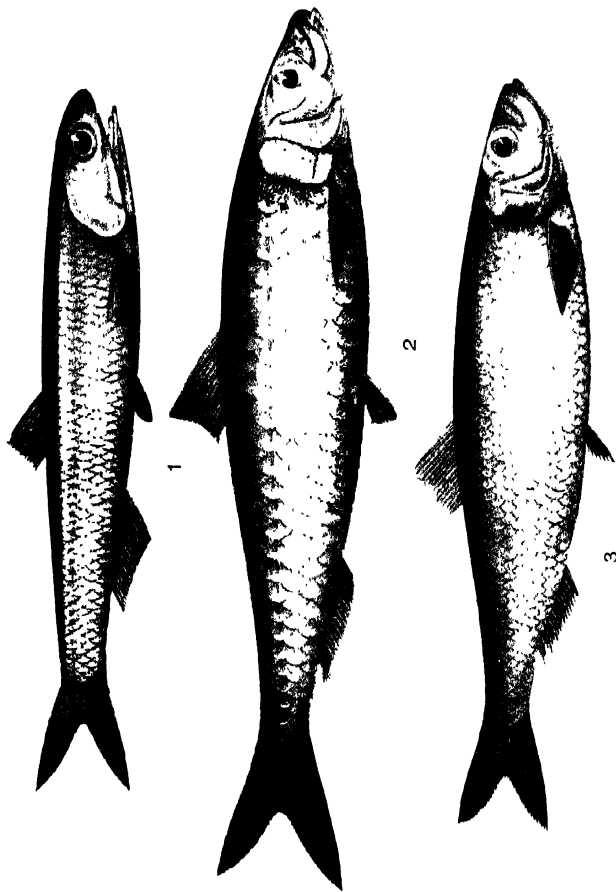
The name " Tench " is derived from the Latin *tinca*, the old French form being *tenche*.

The record for this species caught by fair angling in the British Isles weighed 7 lbs., and was caught by Mr. Stacey in the Pottery Pits at Weston-super-Mare in 1882. One of 6 lbs. 7 ozs. was caught at Rainworth by Mr. J. Whitaker in 1919, and three over 6 lbs. have been taken from the Daventry Reservoir. A Tench of 6 lbs. 4 ozs. was taken from a private water near Aylesbury in August, 1928. Mr. G. Bernard had one of 6 lbs. 2 ozs. in 1911, Mr. J. F. Cramp one of 6 lbs. 1 oz. on the 21st September, 1913, and the third was captured by Mr. W. R. Birney in 1909. The heaviest Tench that has been recorded was taken in November, 1801, when a lake at Thornville Royal, Yorkshire, was drained ; it weighed 11 lbs. 9½ ozs.

The Minnow (*Phoxinus phoxinus*, or *P. lavis*).

This is one of the commonest and best known of our freshwater fish, and may be recognised by its cylindrical body, short





1. Anchovy. (p. 265).
 2. Pilchard. (p. 262).
 3. Sprat. (p. 261).

snout, tiny scales (of which there are from 80 to 100 along the lateral line), and a series of dark vertical bars descending from the back (Plate 107). The scales of the lateral lines have the tubules extending the whole length of the exposed parts. The lateral line sometimes does not extend beyond the level of the pelvic fins, at other times it reaches nearly to the base of the caudal.

The Minnow is distributed from Western Europe to the Amur, including some of the Siberian rivers and Lake Baikal. In Great Britain it ranges north to Banffshire. It is absent from Northern Scotland. In Ireland its distribution is local. One of the smallest of our fresh-water fish, the Minnow rarely exceeds a length of 4 inches.

This handsome and popular little fish is an inhabitant of clear brooks and streams, where it prefers rather deep water and a gravel or sandy bottom. In the Eastern Baltic it is found in great numbers in brackish water.

It spawns from May to July. The males take on a characteristic nuptial coloration, with whitish tubercles on the head and a thickened pectoral fin-ray.

The spawning fish seek shallow sand or gravel banks to deposit their eggs. These are small and adhesive, each female laying about a thousand. The fish congregate together in large shoals during the spawning period, and this forms the occasion of a regular fishery on the Continent, where the Minnow is much esteemed as an article of diet. In England it is used chiefly as bait; formerly it was eaten. At any rate, Isaak Walton gives a recipe for Minnow-tansy; the fish are gutted but not washed, and fried with yolk of eggs, cowslips, primrose and tansy. In 1394 William of Wykeham gave a banquet at Winchester to Richard II., and among the articles on the menu were 7 gallons of Minnow, costing 11s. 8d. According to Tate Regan, the name "Minnow" seems to have some connection with the French *menu*, small. The Anglo-Saxon form is *Myne*, from *Min*, meaning "small."

The Chub (*Leuciscus cephalus*).

The body of the Chub (Plate 107) is rather more elongate than that of allied species. The scales are large and dark at the base. The mouth is large, its cleft often reaching the vertical from the middle of the eye. The pharyngeal teeth are arranged in two rows, five in the inner and two in the outer row. They are long and hooked at the top. The edge of the dorsal fin is straight or slightly convex, that of the anal fin always convex.

The Chub is distributed all over middle Europe, and is in fact restricted to the European-Caspian region. In Great Britain it is generally distributed south of the Forth, except in West Wales, Cornwall and Devon. It is absent from Ireland. In North Wales it is common in Montgomeryshire and in the lower Dee.

The Chub is essentially a surface-living river fish. The young stages are gregarious, and large shoals may often be seen in summer floating near the surface. The older fish, on the contrary, lead a solitary existence. The Chub resembles the Trout in frequenting rapid-running streams and brooks. In cold weather it seeks the bottom, spending the winter preferably in deep water. Although it seems to prefer running water it is ubiquitous and is met with in still waters, where it feeds near the bottom. It is by no means exclusive or fastidious in its diet, since it is both predatory and vegetarian. At one time it devours young fish, frogs, insects, insect larvæ and worms ; at another time it lives on seeds, roots and buds of fresh-water plants and algæ. This difference in diet may be due to the environment or to the seasons, or even to the age of the fish. At the commencement of winter it prefers an animal diet, and its predatory instinct also increases with age. The large mouth, strong jaws and pharyngeal teeth indicate a preference for a fish diet.

The spawning period is in May and June. The eggs are numerous, about the size of poppy seed, and 100,000 are deposited by an adult female. They adhere to stones and water-plants and hatch out in about a week.

In England the Chub attains a length of 2 feet and a weight of 8 lbs.; on the Continent fish of 10 lbs. weight are not uncommon, and in exceptional cases fish of 12 lbs. are recorded. In spite of its size and relative abundance the Chub is not much esteemed, since it is a coarse and bony fish. The Chub is considered a good sporting fish, and it finds much favour amongst a section of anglers.

The name "Chub" is of doubtful origin. According to Skeat it is derived from the Danish *kobbe*, a seal; or Swedish *kubb*, a block or log. Tate Regan gives, with more probability, the derivation as from the same root as chubby, with fat cheeks. At any rate, the names of this fish in different languages have some reference to the shape of the head. In Germany the fish is known as *Dickkopf*, thick-head; in French *chevin* or *chevenden*, from *chef*, a head; the north-country name for this fish, "Skelly," refers to the conspicuous scales and may be compared with the German *Schuppfisch*. The record for this species caught by fair angling in the British Isles weighed 8 lbs. 4 ozs., and was caught by Mr. G. F. Smith at Christchurch in December, 1913. One of 7 lbs. 8½ ozs. was caught in the River Avon at Christchurch by Mr. P. Wooley on the 28th December, 1918. Another ½ oz. less by Mr. Gillett in 1920, from the Avon; and two others of 7 lbs. 6½ ozs. and 7 lbs. 5 ozs. have also been taken from the same river, the former by Mr. F. W. Smith in October, 1906, and the latter by Mr. E. J. Walker on the 17th August, 1904, as well as another of 7 lbs. 6 ozs. taken by Dr. Lewis Smith in December, 1932. The Dorsetshire Stour has produced one good specimen weighing 7 lbs. 3½ ozs., caught at Kinson by Mr. F. J. Woolard in 1911; but the Avon is without question the premier river for Chub.

The Dace (*Leuciscus leuciscus*).

The Dace (Plate 107) closely resembles the Chub, but it more slender, has the body more compressed, the head narrower and the tail fin more forked. The edge of the dorsal and anal fins is concave in the Dace, and the colour of the body and fins lighter than the Chub.

It is distributed right across Central Europe to the Caspian and north to the Siberian rivers, including Lake Baikal. In England it is common and widely distributed. It is not found in Scotland.

The Dace prefers clear streams with fairly rapid water, and like the Chub it is found in trout streams, which it ascends to a higher level than the Chub. It is a small species, the average size being about 10 inches, and it rarely exceeds a foot in length or a pound in weight. It prefers an animal diet consisting of flies, water-insects, crustacea and worms, but occasionally it feeds on water-plants.

Its spawning habits resemble those of the Chub, the period being April and May. Like the Chub, the male in the spawning season develops white tubercles on the head.

The Dace is a pretty and lively fish, affording good sport to the fly fisherman. Its flesh is distinctly better than that of the Chub, but like all the other Cyprinoids it is far less tasty than our salt-water edible fish. It is largely used as bait for Pike. The name "Dace" is derived from the old French *dars*, a dart, and the name is given to the fish on account of the quickness of its movements.

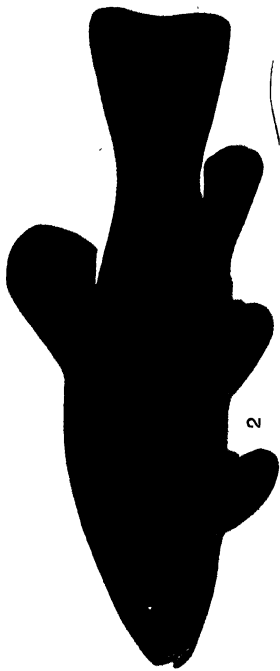
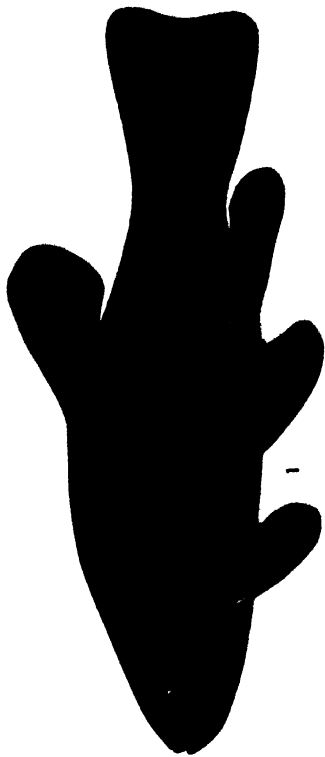
A Lancashire name for the Dace is "Graining," and in certain localities in both Lancashire and Cheshire the fishermen speak of two varieties, the Dace and the Graining, regarding them as distinct species. Shaw, Yarrell and Pennant regarded the Graining as a distinct species, but Tate Regan says, "I cannot see that the Dace of Lancashire differ in any way from



Blue
Smc

P.

Tench. (p 289)
1. Male 2. Female.



those of other parts of England." The etymology of the name "Graining" is doubtful.

The Dace has been recorded from several localities in Ireland, but until recently it was thought that they were merely introduced specimens and not indigenous. Holt, however, from a review of the available evidence, is inclined to think that the Dace found in the Blackwater River is really a native species.

The record Dace caught by fair angling in the British Isles weighed 1 lb. 8 ozs., and was caught by Mr. L. Cookson in the River Ivel. In 1910, Mr. S. Corley had one weighing 1 lb. 6½ ozs. in the River Gade at Watford. Two of 1 lb. 6 ozs. have been caught—one by Mr. R. Robinson in the River Deane near Hertford in 1905, and the other by Mr. Hullett in the Millstream at Christchurch in 1907. Mr. A. R. Matthews had one of 1½ lbs. in the River Deane in 1899, and Mr. G. Spiers had another the same weight at Weybridge in 1908. Comparatively few Dace are taken over 1 lb. in weight.

The Roach (*Rutilus rutilus* or *Leuciscus rutilus*).

The Roach (Plate 123) is a variable species, and though normally the body is moderately deep and compressed it at times has a body as deep as its near relative the Rudd, or it may be slender like the Dace. The "formula" for the fin-rays and scales of the Roach has already been given (p. 281). The roach may be easily distinguished from the Rudd, firstly by the fact that its pharyngeal teeth are in one row (two in the Rudd), and that the dorsal fin originates only slightly behind the base of the pelvic (in the Rudd the dorsal originates a long way behind the pelvic).

The Roach is one of our commonest fresh-water fish. It is found right across Europe to Turkestan and in Siberia to Lake Baikal. In the British Isles it is absent from Ireland, rare in Cornwall, Devon and West Wales; in Scotland it ranges as far north as Loch Lomond.

It is found in both still and running water, and in the Eastern Baltic it strays into brackish water, in some districts being very abundant. In some instances it is found in water which is appreciably salt. The Roach is a fish of medium size, attaining a weight of 3 lbs. and over. According to Tate Regan, the largest Roach known from English waters was one weighing 3 lbs. 10½ ozs. taken in November, 1904, from the Bristol Water Company's reservoir. This fish was 17 inches long.

The Roach prefers rivers or canals where the stream is not too rapid. It is a lively and crafty fish, usually swimming in shoals. To some extent it avoids the light, being usually a bottom feeder, but in warm weather it will take flies at the surface. In winter Roach retire into deep water, and at this season large catches are made in Continental waters.

The Roach spawns in April and May in shallow water; the adhesive eggs are deposited on water-weeds and submerged plants (Plate 66). The eggs are numerous, small and so transparent that they are hard to distinguish. The yolk is of a pale yellow colour. After ten to fourteen days' incubation the young larvæ are hatched out. For a time they rest quietly on the bottom, and only when the yolk has been absorbed, a process which takes from eight to ten days, do they begin to move about. At this stage the young Roach may be seen in dense shoals among the water-weeds near the banks.

The flesh of the Roach is white and firm, but the fish generally has a rather muddy flavour.

The name "Roach" is derived from the Anglo-Saxon word *reohke*, cognate with the Dutch *rog*, a ray; Danish, *rokke*, a ray.

The record Roach caught by fair angling in the British Isles up to the present weighed 3 lbs. 11½ ozs. caught in Mapperley Reservoir near Ilkeston, Derbyshire, in August, 1932. The second weighed 3 lbs. 10 ozs., and was caught by Mr. W. Cutting in Hornsea Mere on the 15th August, 1917.

On the previous day Mr. Cutting had one of 3 lbs. 4 ozs., a 3-pounder, and 15 others: total aggregate weight of the 17 fish, 41 lbs.

A roach of 3 lbs. 3½ ozs. was caught in the River Colne by Mr. Lloyd in September, 1905; and one of 3 lbs. 2 ozs. in the Barnes Elms Reservoir, Hammersmith, by Mr. H. Blackman, 9th July, 1923. Several others of 3 lbs. are recorded. The largest specimen on record, weighing 3 lbs. 10½ ozs., was secured on the 18th November, 1904, at the emptying of the Barrow Gurney Reservoir, Bristol. Hornsea Mere has yielded a larger number of Roach over 2 lbs. than any other water. In 1915 Mr. E. Kempsey had 19 roach, aggregating 41½ lbs.; in 1919 Mr. J. H. R. Bazley took 50 Roach, all over 2 lbs., in one month. On two occasions Mr. Bazley landed a brace at a time, one brace scaling 5 lbs. and the other 4 lbs. 6½ ozs. What is probably the record "bag" was taken on the 8th July, 1920, by Mr. G. W. Tether and Mr. H. Field—61 Roach, weighing 123 lbs., an average of just over 2 lbs. apiece.

The Rudd (*Scardinius erythrophthalmus*).

The Rudd (Plate 123) closely resembles the Roach. The distinguishing characters have already been given (p. 295), and it must be remembered that the Rudd is usually deeper in the body than the Roach. In the Rudd, moreover, the abdomen behind the ventral fins is compressed into a keel and the scaling is continuous over this keel. The mouth is terminal, larger and more oblique than that of the Roach. The iris in the Roach is a deep red, in the Rudd a brassy yellow. The red colour of the fins of the Rudd is much deeper than in the Roach. Finally, the pharyngeal teeth afford an unmistakable distinction between the two species.

The Rudd is not quite so widely distributed as the Roach, but it extends nevertheless from Ireland and England to

Turkestan. In England its distribution is rather local, and in Scotland it is not found.

It is a quiet fish, characteristic of lakes and sluggish rivers, where it prefers weedy places. It is a lazier fish than the Roach. Its spawning habits are very similar to those of the Roach.

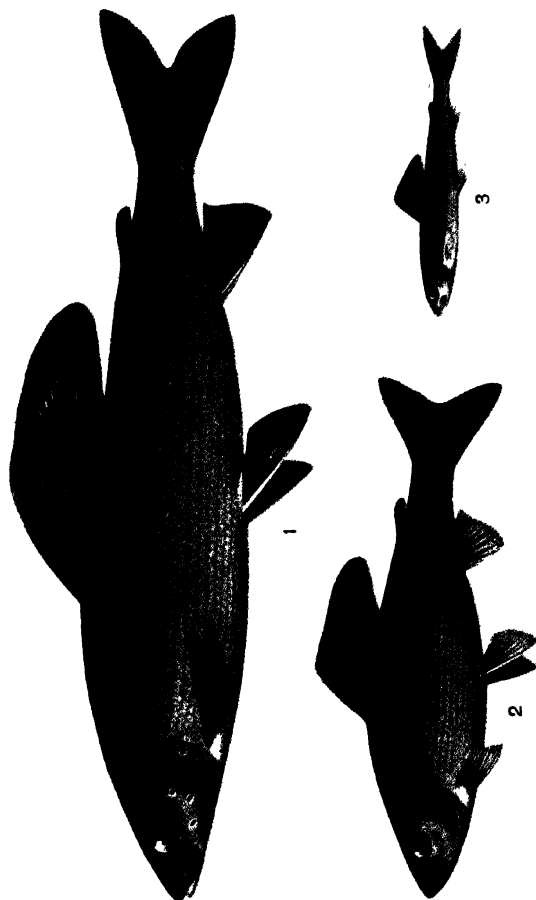
The Rudd is not greatly esteemed as a food fish, and apart from certain localities, such as the Norfolk Broads, is not much fished for by anglers.

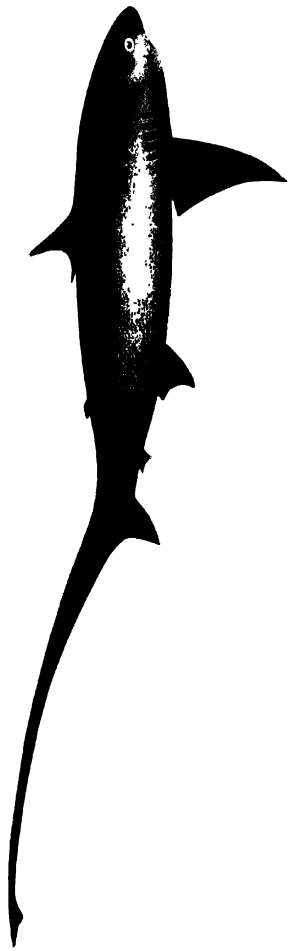
The name Rudd is derived from the Anglo-Saxon *rudu*, meaning redness, and is given to the fish on account of its ruddy coloration.

A species known as the "Azurine" or "Blue Roach" was described by Yarrell under the name of *Leuciscus cœruleus* from Knowsley in Lancashire. Tate Regan, who has examined Yarrell's specimens in the British Museum, sees no difference between them and other Rudd of the same size from other localities.

The White Bream (*Blicca bjoernka*).

The body of the White or Silver Bream (Plate 124) is strongly compressed, the length being three times the depth. The snout is blunt. The mouth is terminal, oblique and small, the opening extending only just under the anterior nostril. The eyes are large, the iris silvery. The pharyngeal teeth are in two series, usually five in the inner and two or three in the outer row. The dorsal fin commences in the middle of the body length; it is high and pointed. Apart from the pharyngeal teeth the number of scales serves to distinguish the species from its near relative, the Bream. In the White Bream the scales along the lateral line number from 44 to 50, from the origin of the dorsal to the lateral line there are 8 to 11, from the lateral line to the base of the pelvic fin there are 5 or 6; in other words, the "formula" for the scale of the White Bream is





Pl. 121

Thresher Shark, (p. 319)
Six-gilled Shark, (p. 319)

Pl. 299.

L.l. 44-50, L.tr. 8-11/5-6, whereas for the Bream the formula is L.l. 51-57, L.tr. 12-13/6-7. In the Bream all the fins are bluish-grey. In the White Bream the pectoral and pelvic fin are entirely or partially red or orange-coloured. Moreover, in the Bream the scales are more easily detached than in the Silver Bream. The eye in the Silver Bream is relatively larger than that of the Bream.

On the Continent the Silver Bream is one of the commonest fresh-water fishes. It extends from Central Europe to the Caspian. In England it is confined to the Eastern Counties from Yorkshire to Suffolk. It must be regarded as a rare fish in England, preferring lakes or slow-running streams, where it is found in the neighbourhood of the banks in shallow water. The White Bream congregates together in shoals and is typically a bottom-living fish, feeding on worms, crustacea, molluscs and insect larvæ. It attains a weight of a little over a pound and a length of a foot. The spawning period is in May and June, when the fish assemble in shoals in shallow water, preferably where there are water-weeds. The eggs, about 2 millimetres in diameter, are laid on the water-weeds. At the spawning time the fish splash about in the water and constantly leap out of it, so that the spawning place can easily be recognised even from a distance.

The female produces about 100,000 eggs in a season. The flesh of the fish is of poorish quality, and they are not much used as food. They are not considered a sporting fish, as they make little or no attempt to escape when hooked.

The Bream (*Abramis brama*).

The chief points of difference between the Bream (Plate 126) and White Bream have already been given. In addition to those already mentioned (p. 298), the anal fin is longer in the Bream, there being 3 unbranched and 23 to 28 branched rays,

compared to the 3 unbranched and 19 to 21 branched rays in the White Bream. The younger stages of these two species are often confused, but if careful attention be given to the points enumerated above there should be no difficulty in distinguishing them apart at any stage of their life-history. On account of the younger forms being so similar in colour and general appearance they have been described together as "Bream-flats." These, however, are not a distinct species.

The Bream is found in Central Europe, extending eastwards to Turkestan and Western Siberia. In Great Britain it is found chiefly in the east and south, being absent from the west of Wales and from Scotland north of Loch Lomond. In the Baltic it is found in brackish water. A bream of from 10 to 12 lbs. weight would be considered a large fish, but according to Tate Regan the record fish for Great Britain is one of 17 lbs. from the Trent.

It is a gregarious fish, congregating together in large shoals. The life-history and habits of the Bream are better known than some of the allied species. When quite young it feeds on the small, and for the most part microscopic, organisms which are found floating in the water. When a little over 3 inches long it makes its way to the bottom near the bank, preferring still water or slow-running streams. Here it feeds on worms and bottom-living crustacea and molluscs. In its second year it makes another migration, this time to the bottom in deep water, avoiding the light. At night it leaves the depths for shallow water in order to seek for food. It stirs up the mud on the bottom with its projecting snout, feeding on organic matter extracted from the mud and on insect larvæ, worms and shell-fish. The Bream is shy and crafty, hiding itself in the mud it stirs up from the bottom. The deep shape of the body also protects it to some extent from being devoured by predatory fish like the Pike. The form of the Bream is, however, subject to great variation. On the one hand there is a long slender

variety, the so-called "Hunger form," and on the other extreme the deep or high body characteristic of well-fed fish. In winter the Bream assembles in shoals which betake themselves to deep water, where they rest during the cold weather.

The spawning time is May and June, and at this time the Bream shoals seek shallow waters near the banks, preferably where there is an abundance of water-weeds. Here the fish dash about, making a great noise, leaping and splashing at the surface. The adhesive eggs are deposited on water-plants. They are of a light yellowish colour and about $1\frac{1}{2}$ millimetres in diameter. A female produces from two to three hundred thousand eggs. The period of incubation is from one to three weeks. In any particular pond or stretch of water the bream generally spawn in three groups, the oldest and heaviest first, followed by the others at weekly intervals. As soon as the spawning period is over the fish again seek the shelter of deep water.

In Great Britain the Bream is not much esteemed as food, but on the Continent there is a regular fishery for it. The Pomeranian Bream described in Yarrell's British Fishes is really a hybrid of the Common Bréam and the Rudd.

The name "bream" is derived from the Low Latin *bresmia* or *braximus* and Old French *brême*.

The records for this species taken by fair angling in the British Isles come from the Tring Reservoirs where one was taken weighing 12 lbs. $12\frac{1}{2}$ ozs. in July, 1931. On 28th July, 1933, three were captured at Tring weighing $10\frac{1}{2}$ lbs., 12 lbs. and 12 lbs. 14 ozs. Another weighing 11 lbs. 12 ozs. was caught in the River Blackwater, Ireland, by Mr. A. Pike in July, 1882. On the 22nd April of the same year, Mr. Hilditch, of the Enterprise Angling Society, Highcross, Tottenham, landed one of 11 lbs. $3\frac{1}{2}$ ozs. from the Ordnance Pool. One other of $9\frac{3}{4}$ lbs. was caught by Mr. R. McMullen in the Blackwater in 1882; and on the 6th July, 1919, Mr. W. Ashton

had a 9½-pounder from the Thames at Eynsham. Dr. Day refers to a record of a 17-lb. Bream from the River Trent, and other specimens up to 14 lbs. are mentioned. A Bream weighing 11½ lbs. was caught in a net at Beeston Regis, Norfolk, 17th June, 1879; it was weighed by Frank Buckland and shown at various exhibitions, including the International Fisheries Exhibition, 1883. In 1923 a Bream weighing 10 lbs. 3 ozs. was found dead in the River Thames.

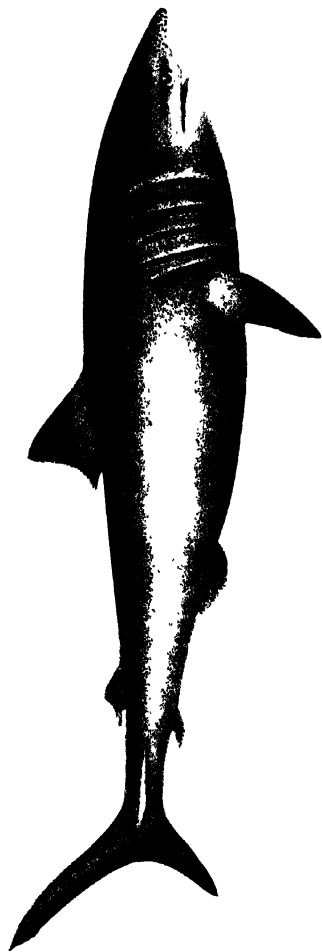
The Bleak (*Alburnus lucidus*).

The Bleak (Plate 124) has a narrow elongated body, with the mouth oblique and the lower jaw projecting. The origin of the anal fin is under the base of the dorsal. The scales, which are easily detached, form a sharp keel between the pelvic and anal fins. The fish varies considerably in colour in different regions, but as a rule it is silvery-white, with the back greenish.

It extends from Central Europe to the Caspian Sea. In England it is only found south of the Tees, and is absent from Ireland.

It lives in shoals and prefers still water and slowly running streams. The Bleak is a small fish, rarely exceeding 8 inches in length. A beautiful and lively little fish, it may be seen on summer days at the surface darting about and springing up at flies, feeding on these and worms, crustacea and insect larvæ. It is much preyed upon by water-birds. The spawning time is April to June, and for this act shallow water is preferred, the eggs adhering to stones or water-plants.

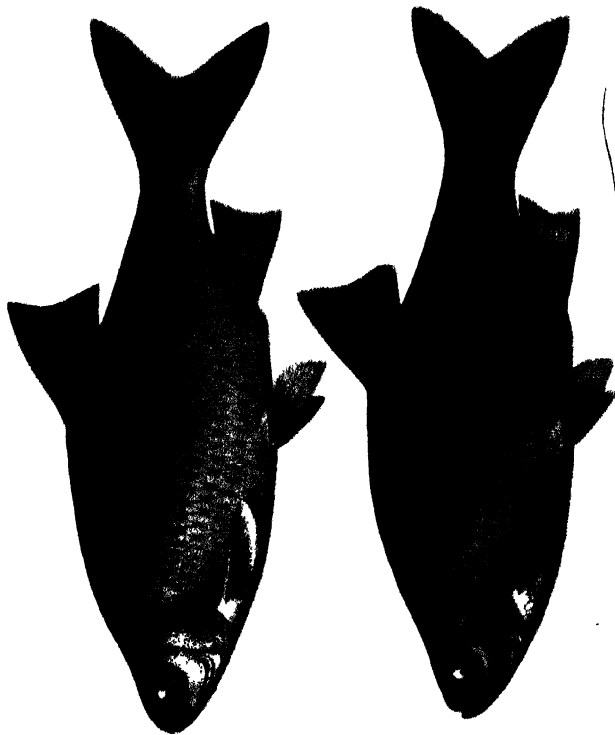
The Bleak is not much esteemed as food, neither is it a sporting fish. It is sometimes used as a bait for other fish; but its chief commercial importance arises from the fact that the scales are used in the manufacture of artificial pearls, and there is on the Continent a regular fishery for the Bleak for that purpose. The trade is said to have commenced in France in



P. 122.

Basking Shark. (p. 114).
Black-mouthed Dogfish. (p. 119)

U. 302.



Pl. 123.

Roach. (p. 265).
Rudd. (p. 267)

U 303.

1656. Thousands of people are engaged in the capture of the Bleak when the fishery season is on. A pound weight of scales, even at pre-war prices, would fetch from 4s. to 9s., and to produce this fish weighing from 50 to 100 lbs. would be required, or from four to eight thousand fish. From the scales, which are salted in order to preserve them, the silver essence (*Essence d'Orient*) is prepared by scraping. Hollow glass beads are coated on the inside with this essence and then filled with wax, and it is said that the best artificial pearls prepared in this fashion are hard to distinguish from real pearls. The silvery colour of the scales of this and other fish is really due to small crystals of calcium carbonate and nitrogenous matter, excretory products of the fish which are deposited on the under sides of the scales. These crystals have no coloration of their own, but in combination with the pigment cells in the fish's skin produce the brilliant silvery appearance which is characteristic of so many fish.

The name "Bleak" is of Anglo-Saxon origin; it is derived from the word *Bloec* or *Blac*, meaning pale, shining or white, and the fish is so named on account of its brilliant white colour.

THE LOACHES (Cobitidæ).

This family is nearly related to the Carps. The Loaches are characterised by the fact that the pharyngeal teeth, eight to fourteen in number, are arranged in a single row. The body is elongated, with the scales very small, and there are at least six barbels. The dorsal and anal fins are both short. The air-bladder is partly or entirely closed in a bony capsule. Many loaches use their intestine as an accessory organ of respiration, and under certain circumstances this method becomes the principal means of breathing, for instance, when the ponds in which the Loach lives become dried up. This method of breathing can be observed in aquaria, in which loaches are

easily kept. They come to the surface and take in a bubble of air through the mouth ; this bubble passes into the alimentary canal and out through the anus. After the bubbles have passed through the Loach's intestine they have been found to contain less oxygen and more carbon dioxide than ordinary air, so that we have unmistakably a case of intestinal respiration. In the ponds which the Loach inhabits there is usually in summer a deficiency of oxygen, or the pond may even become dried up altogether, in which case the Loach buries itself in the soft and damp mud which remains. Its only salvation then is in the intestinal respiration, which entirely supersedes the normal breathing by means of the gills. Experiments carried out in aquaria prove that in well-oxygenated water of moderate temperature the normal respiration of the Loach is by means of the gills, and the fish does not come to the surface for the ingestion of air-bubbles at all. At 41° F. there is no intestinal respiration ; at 50° F. a single air-bubble is swallowed on the average every two hours ; at 59° F. five bubbles are taken in every hour ; at 77° F. this number is doubled. If the fish be placed in water which has been boiled to drive out the dissolved oxygen and then cooled down to 77° F., it has been observed to come to the surface twenty-seven times in an hour and swallow sixty-seven bubbles.

Loaches are popularly supposed to give twenty-four hours' notice of the approach of a thunderstorm, through their obviously disturbed and uncomfortable movements. Although this has been doubted, there is unquestionably some ground for believing that these fish, and especially the Continental species *Misgurnus fossilis*, can indicate weather changes.

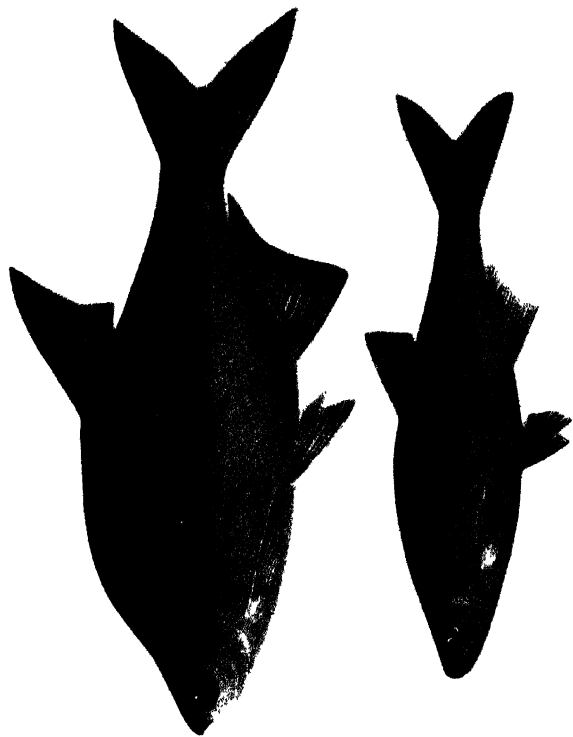
There are two British species of Loach, which may be distinguished by—

Two long, four short barbels.

(1) Stone Loach, *Nemachilus* or *Cobitis barbatula*.

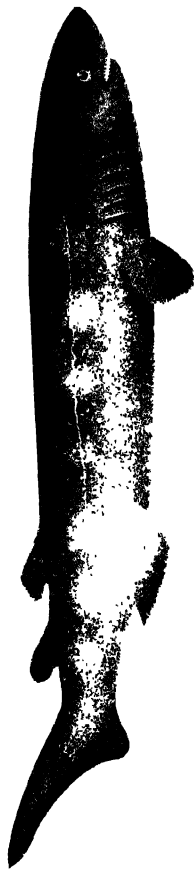
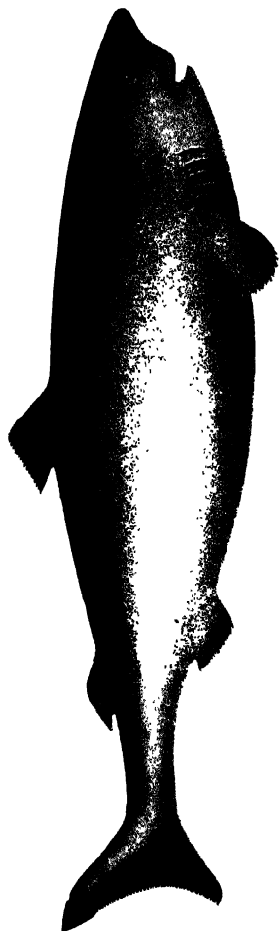
Six barbels of equal length.

(2) Spined Loach, *Cobitis tania*.



Pl. 12.

White, or Silver Bream. '1 205),
Bleak. (p 302),



P 125.

Greenland Shark. (p. 32.)
Spinous Shark. (p. 32.)

X 305.

The Stone Loach (Plate 116) is widely distributed in Great Britain (except in the Northern Highlands of Scotland) and Ireland, and attains a length of 5 inches. The Spined Loach (Plate 116) is rarer, being absent in Scotland, Wales and Ireland. It attains a length of 4 inches. It is found in the Trent and in Cambridgeshire, Wiltshire and Warwickshire.

ACIPENSERIDÆ.

The Sturgeon (*Acipenser sturio*).

The Sturgeon (Plate 108) is a primitive fish of anadromous habits. It belongs to a sub-order of fish known as the Chondrostei, which in former geological times were more abundant than they are at present. In Palæozoic and Mesozoic rocks remains of these fishes are very abundant. The Sturgeon is one of the few survivors. Sturgeon, of which more than twenty species have been described, are exclusively found in the temperate region of the Northern Hemisphere. There is only one species in Western Europe, the common Sturgeon (*A. sturio*), which is not infrequently taken in British waters. It is certainly remarkable how nearly every year one or more examples of the Sturgeon are taken in the same place on the west coast; this has come under the author's personal observation repeatedly in the fishery baulks near Morecambe and in the trawl of inshore fishery boats and draw-nets (seines) off Pwllheli, on the south coast of Carnarvonshire. The Sturgeon grows to a large size, specimens of 10 feet in length being not uncommon, and 14 feet is occasionally attained. The eggs are very small, and the ovaries of an adult female will contain about three million. From the eggs is prepared the delicacy known as caviare, and from the inner coat of the air-bladder isinglass is prepared. In places where the Sturgeon is abundant, as in the Volga, it is subject to a regular fishery which is valuable and important.

In British waters there is no fishery for the Sturgeon, and although it ascends our rivers to a considerable distance, being recorded in the Severn at Shrewsbury and the Trent at Nottingham, it is not known to spawn in British waters. On the Continent the spawning migration takes place from March to July. The eggs are demersal and adherent, being provided with a gelatinous investment. The young leave the fresh water at the end of summer. The Sturgeon feeds chiefly on small invertebrates. It is a "royal" fish; when captured in British waters it is the prerogative of the Crown. According to Gunther the common Sturgeon of the United States (*A. maculosus*) sometimes cross the Atlantic to the coasts of Great Britain, but Tate Regan cannot distinguish these from the common Sturgeon.

THE TRUE SHARKS (Carchariidæ).

Cartilaginous fish with the snout produced longitudinally or transversely. Eye with a nictitating membrane. Mouth crescent-shaped, inferior. Two dorsal fins; the first, devoid of a spine, is opposite to the space between pectoral and pelvic fins. Anal fin present.

There are four British species of the true sharks, each belonging to a distinct genus:

- | | |
|------------|---|
| | (Snout longitudinally produced. |
| No | The Blue Shark (<i>Carcharias glaucus</i>). |
| spiracle. | Snout transversely produced. |
| | The Hammer-headed Shark (<i>Zygæna malleus</i>). |
| | , Teeth flat, triangular, oblique, notched and serrated. The Tope (<i>Galeus vulgaris</i>). |
| Small | } Teeth small, numerous, obtuse, arranged like a pavement. |
| spiracles. | |
| | The Smooth Hound (<i>Mustelus vulgaris</i>). |

The Blue Shark (*Carcharias glaucus*).

This family comprises true sharks which lead a predatory, roving and pelagic life swimming about in the upper layers of water. In the Blue Shark (Plate 118) the snout is longitudinally produced and covered with numerous fine punctures. The cleft of the mouth is deep and its gape wide, armed with a series of large flat triangular teeth which, when the fish is young, are smooth; later in life the teeth are serrated. The body is long and slender. There are two spineless dorsal fins, the first opposite the space between the pectoral and pelvic fins. An anal fin is present. There are no spiracles. There is a transverse pit on the back of the tail at the root of the caudal fin. The back and upper half of the body are of a deep blue colour, whence the name. The Blue Shark attains a length of 25 feet; individuals of from 12 to 15 feet in length are common. The *Carchariidæ* are viviparous. This species is oceanic and of wide distribution. Day gives numerous references to specimens captured in British waters, particularly off the coast of Cornwall. It is not often taken in the Irish Sea, but there is a specimen in the Liverpool Museum taken off the Ormes Head in September, 1882, which measured 5 feet 10 inches in length. In Cardigan Bay it has been taken in herring nets off Aberdovey, the largest measuring 10 feet and weighing 263 lbs.

A Blue Shark between 9 and 10 feet long was recorded from the coast of County Mayo in 1900, and a female 5 feet 4 inches long was caught by long-liners 180 miles south-east of Aberdeen in September, 1895, and landed at the Aberdeen market. Another specimen 8 feet 6 inches long was caught in nets in Ayr Bay in September, 1899. Other Scottish records are Kinghorn Beach, November, 1894; and Gullane Point, East Lothian, in July, 1898. This last fish was 5 feet long (Evans). According to McIntosh, the Blue Shark is not uncommon in St. Andrew's Bay in the summer months.

The Hammer-headed Shark (*Zygæna malleus*).

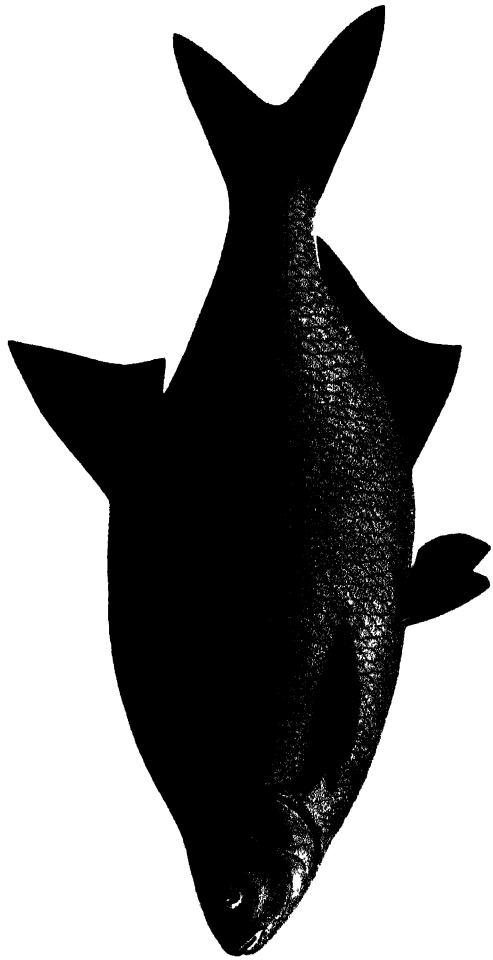
This shark may be easily distinguished from other sharks found in British waters by the fact that the anterior portion of the head is broad, flattened and laterally produced, with the eyes situated at the lateral extremities and the nostrils at the fore border. The front portion of the head therefore resembles a hammer, and from this peculiarity the fish receives the name of Hammer-headed Shark. There are no spiracles. The mouth is crescent-shaped; the teeth, similar in both jaws, are obliquely placed and notched. There are two spineless dorsal fins, the first situated above the space between the pectorals and pelvics. An anal fin is present.

The Hammer-headed Sharks are tropical species with wide distribution. Day records five specimens of this species from British waters. It must be extremely rare, as in twenty years the writer has never seen it in British waters, though it was commonly taken by him in the trawl in the Bay of Bengal on the Bengal fishery steamer the *Golden Crown*. Cantor, in his "Malayan Fishes," records finding 37 embryos in a female 11 feet long, and according to Day there were 31 embryos ready for exclusion inside a specimen taken in Carmarthen Bay. Though not a particularly large species when compared with other oceanic sharks, this fish has been recorded up to a length of 13½ feet.

The Hammer-headed Shark lives to some extent on Sting-rays (Trygon), since an American specimen 12½ feet long was found to contain in its stomach a complete skeleton of a Sting-ray, and in addition in its muscles and throat no fewer than 50 spines of Trygon were found.

The Tope (*Galeus vulgaris*).

The Tope (Plate 129) is one of the smaller sharks in which the snout is produced longitudinally. The mouth is crescent-



N. 126.

Bream. (p. 249)

A 308.



Pl. 127.

Monk Fish. (p. 325).

X 309.

shaped, the teeth equal in both jaws, small, flat, triangular, oblique, serrated and with a notch. The spiracles are small. The first dorsal fin is devoid of spines, and is situated above the space between the pectorals and pelvics. There is a single notch at the lower margin of the caudal fin.

This species has a wide distribution and is common on British coasts and in the North Sea. It is a bottom-living fish and is viviparous, the young being born in shallow water, where they remain after the parents have migrated to greater depths offshore. From twenty to forty young are born at a time. The Tope is ferocious and has a bad reputation, especially among line fishermen, whose bait it devours.

It is by no means uncommon off the Welsh coast, and is known to Welsh fishermen as Ciglas, literally Blue Dog. With other species of dogfish it forms a constituent of the "Darwen salmon." The Tope does not attain a large size, specimens of from 5 to 6 feet being rare. A specimen 4 feet 6 inches long has been taken in the estuary of the Dee near Saltney, and is now in the Grosvenor Museum, Chester.

Day gives numerous references to the capture of the Tope. Of recent years records are fairly numerous. Holt and Calderwood caught one in the trawl in 154 fathoms off County Mayo in April, 1891. The writer obtained a small specimen in the trawl off Aberporth, Cardiganshire, on the 22nd June, 1924, at a depth of 20 fathoms.

The Smooth Hound (*Mustelus vulgaris*).

The Smooth Hound (Plate 118) is a species of small shark superficially resembling the Tope. The chief difference between the two aspects is to be found in the teeth, which in the Smooth Hound are very small and numerous, similar in both jaws, obtuse or with very indistinct cusps, and arranged like a pavement. In the Smooth Hound the snout, though produced longitudinally, is not so elongated as in the Tope. There is

also no distinct lower lobe to the caudal fin in the Smooth Hound. There are five species of Hounds common near the coasts of all temperate and tropical seas, but only one, *Mustelus vulgaris*, is a British form.

The Smooth Hound is a fairly common species in British waters, being found at times on all our coasts. It is not caught to any extent in the trawl, as it is a surface swimmer or at least lives in the upper layers of water. Day gives numerous records for the Smooth Hound. In the Irish Sea it is only rarely met with, probably because the predominant method of fishing, trawling, is not designed to catch it.

The Smooth Hound is somewhat similar in size to the Tope; specimens of 3 to 4 feet are not uncommon; rarely it attains a length of 6 feet, though a specimen has been recorded from France $6\frac{1}{2}$ feet long. This species is viviparous, the number of young varying from eleven to twenty, but Risso refers to a case where sixty young were produced at a birth. Like many of the shark-like fish the Smooth Hound approaches our coasts in the summer, and this migration is probably for spawning purposes. At any rate the young are born in shallow water, where they remain after the adults have again moved out to deeper water. The food of the Smooth Hound consists principally of molluscs and crustacea; it seems to prey less on other fish than the majority of sharks.

LAMNIDÆ.

This family of sharks differs from the preceding in that there is no nictitating membrane to the eye. There are two dorsal fins; the first, devoid of a spine, is opposite the space between the pectoral and pelvic fins. The nostrils are not confluent with the mouth, which is on the under surface of the body. There is an anal fin. There are three British genera,

each represented by one species. They are differentiated by the following peculiarities :—

Teeth lanceolate, large, with smooth edges. A keel at side of tail. The Porbeagle (*Lamna cornubica*).

Teeth triangular. No keel at side of tail. Caudal fin of great length. The Thresher (*Alopias vulpes*).

Teeth very small, numerous, conical and smooth. A keel at side of tail. Basking Shark (*Selache maxima*).

The Porbeagle (*Lamna cornubica*).

This shark (Plate 129), which attains to a very large size, is a surface-living form, widely distributed in tropical waters and occasionally wandering into British seas. In this fish the second dorsal, pelvic and anal fins are very small. The body is thick and high in front, becoming narrower near the tail, on the side of which there is a prominent longitudinal keel.

The mouth is wide, with the teeth large, lanceolate, not serrated but sometimes with additional cusps. The third tooth on either side of the mid-line on the upper jaw is small. The gill openings are very wide and the spiracles minute.

In some instances, even at the present day, confusion arises as to whether a stranded animal of medium or large size is a shark or a whale, so it may be well to state the differences between the two creatures. In a shark the tail is vertical, in a whale or porpoise or dolphin (cetacea) it is horizontal. A shark has from five to seven gill slits in front of the pectoral fins ; there are no gill slits in a whale, but a blow-hole on the top of the head. The skin of a shark is rough, that of a porpoise smooth. A shark has two pairs of fins on the under-surface of the body ; a whale or other cetacean one pair of fins or paddles, which correspond with the first pair or pectoral fins of the shark. A shark usually has several rows of teeth in the mouth ; a whale has either whalebone, dependent from the upper jaw, or one row of teeth only.

The Porbeagle is rather a rare visitor to the British coast. Day gives about twenty-four records for Great Britain and five for Ireland.

Since Day's time it has been recorded in Ireland by Duerden in Dublin Bay in 1894, and by Warren in Killala Bay in 1900. In Scotland it has made its appearance in the Firth of Forth (Evans, 1905); Moray Firth (Taylor, 1910); at Nairn, September, 1899 (two specimens); at Lossiemouth (1899), and in Dornoch Firth (Fulton, 1900). Kermode describes its visit to Manx waters in 1897, but, although there are doubtless other records, the Porbeagle is a rare visitor, though according to Calderwood it is not uncommon along the east coast of Scotland from the Shetlands to the south. The Porbeagle is also known as the Beaumaris Shark, because Pennant described a specimen of the species obtained from that locality, in his book on "British Zoology" published in 1776. It is occasionally taken in the weirs in the Menai Straits. The Porbeagle is viviparous, from two to five young being produced at a birth. A large shark, commonly attaining a length of 8 feet and occasionally 10 feet, the Porbeagle is said to be a fierce and wary fish. Its teeth are not adapted for cutting, but more for seizing its prey, which it probably swallows whole.

Its food consists of whiting, mackerel and dogfish.

Later records for Irish waters are of a specimen 9 feet long, the largest recorded for Ireland, captured in 1902, and two females found stranded on Enniscrone Sands in 1904, one 7 feet long, the other 6 inches shorter. At least five examples were taken in cod gill nets in the Firth of Forth in the winter of 1901-2; of these only one was a male. They were from 7 to 9 feet long and in one case eleven hooks with the hair "snoods" attached were found in the stomach, the shark having passed along the fisherman's line and removed the haddocks and other fish by biting the snoods.

The Thresher (*Alopias vulpes*).

The Thresher or Fox-shark (Plate 121) is easily distinguished from all other British sharks by the extraordinary length of the caudal fin, which has a pit at its root. The second dorsal and anal fins are very small, and there is no keel on the side of the tail. The teeth in both jaws are equal in size, flat, triangular and unserrated. This is one of the commonest of the larger sharks found on British coasts. Of cosmopolitan distribution, the Thresher is most abundant in the Mediterranean and Atlantic. It rarely wanders as far north as the Norwegian coast. Reaching a length of 15 feet, of which the tail measures about, or rather more than, one half, the Thresher is a formidable-looking fish, though really quite a harmless species. It is supposed that the Thresher uses its long tail to drive pelagic fish together, swimming round them in circles and splashing the water with its tail. Herring and mackerel are thus frightened, and when crowded together they form an easy prey. Buckland found twenty-seven mackerel in the stomach of a Thresher, and indeed this fish is not infrequently caught in herring and mackerel nets.

The breeding habits of the Thresher are not known, but it seems likely that the young are born in summer.

In 1893 a Thresher 9 feet long was caught in a fishing weir near Llandudno, and another in the weir in the Menai Straits in 1905; this last fish is now in the Bangor University College Museum. Day gives a number of references of the occurrence of the Thresher in our waters. Since Day there are records from Lowestoft in 1897 and 1906 (Southwell); and off the Devonshire coast in 1885. In Ireland a Thresher 16 feet long was taken at Sheep Haven, County Donegal, in the summer of 1905. A photograph of this fish was sent to the Dublin Museum. If the measurement be correct this is the largest Thresher hitherto recorded in British or Irish waters. According to Sim

the Thresher has several times been captured off the Aberdeen coast : one was taken off Crail in August, 1899 ; another 11 feet long in Girvan Bay in the Clyde in July, 1901 (Duthie). The Crail specimen was 13 feet 10½ inches long, the length of the tail being 6 feet 11 inches. The colour of the body was light slate-blue. In the winter of 1901-2 a Thresher 14 feet long was taken in the trawl in the Firth of Forth, having in its stomach half a bushel of Garfish (*Belone vulgaris*). A male Thresher 15½ feet long was caught off Cullercoats in July, 1902, and another 15 feet long in 10 fathoms off Marsden in August, 1926.

The Basking Shark (*Selache maxima*).

This shark (Plate 122), the largest of the North Atlantic may be recognised from the following characters. The gill openings are very large ; the branchial arches are provided with a broad fringe of long and thin gillrakers. These gillrakers, which are from 5 to 6 inches in length, consist of an elastic apparatus of dentine of the same microscopical structure as the teeth. The functions of these gillrakers is to serve as sifting organs, filtering the water of marine organisms.

The Basking Shark lives on small floating organisms of the plankton, and in this respect differs from all other sharks.

The second dorsal and anal fins are small. The caudal fin, which has a lower lobe, has a pit at its root. There is a keel or ridge at the side of the tail. The teeth are very small, numerous, conical, without lateral cusps and devoid of serrations. The Basking Shark is a quite inoffensive fish of oceanic habit, approaching our western coasts in spring. Off the Irish coast it is reported with some regularity in May, and by August it reaches the coasts of Norway. It is occasionally met with in summer in the North Sea.

The Basking Shark is sometimes solitary in its habits, sometimes it may be seen off the Irish coast swimming about in shoals of from sixty to a hundred individuals. According to Day there was formerly a regular fishery for this species off the Norwegian coast, the method of hunting being by means of a harpoon similar to that used in whaling. The fish is hunted for its liver, which is large as in most sharks, and from it a valuable oil may be extracted, up to 150 gallons or 8 barrels from a single individual.

The Basking Shark attains to a great size; specimens have been recorded up to 36 or even 40 feet in length. Day gives about fourteen separate records from the coasts of Great Britain and five from Ireland. There are also records from the Cornish coasts in 1885 (Gatcombe), from Torquay Harbour (Pengelly, 1891), and from Loch Broom (Murie, 1906). A young one about 8 feet long was captured in Maidens Bay near Turnberry in September, 1898.

A small specimen about 8 feet long was captured near Turnberry in the Clyde in 1901, and a large individual was stranded on the Little Cumbrae in the Clyde in 1912. It was a female with the tail missing, the estimated length being 28 feet.

Its colour was almost black dorsally, shading down to a slaty-grey below, with an irregular mid-ventral streak.

In 1923 a large Basking Shark was taken by a steam trawler in the North Sea in 60° 10' N. Latitude and 2° 50' E. Longitude, to the east of the Shetlands. The weight of this specimen was between 7,000 and 8,000 lbs.

There are records of ten captures off the coasts of Ireland, Iceland and Norway in the period 1885-1905.

The Basking Shark is frequently found to have specimens of the marine lamprey attached to it by means of the suctorial disc which the lamprey possesses.

A Basking Shark captured on the Ayrshire coast in August, 1922, had three specimens of a rare copepod parasite

on the gills. This particular parasite, *Nemesis robustus*, had previously not been recorded in British waters.

One of the Irish specimens, from Inishbofin, 27 feet long, is in the Irish National Museum. One slightly larger, 27 feet 9 inches long, was washed ashore at Portgordon (Scotland) in October, 1899; and another, a male, was stranded at Kingston in the Moray Firth in 1900. A Basking Shark 24 feet long was stranded at Bennan Head, Isle of Arran, on the 30th August, 1922, and parts of its branchial strainers sent to the British Museum.

According to Scharff there was formerly a fishery for this species off the Irish coast. The oil is valuable, one Basking Shark yielding as much as 100 gallons, worth from £50 to £100. The fishing was abandoned because the sharks became less abundant, though they are still by no means rare. In May, 1912, two were taken in drift nets off Youghal, measuring 22½ and 23½ feet in length. In the years 1912-14 ten specimens were killed in Ardmore Bay in salmon nets, where they are a serious menace to the salmon fishery. Large numbers of these sharks were seen off Ardmore Bay in April, 1918.

The Six-gilled Sharks (*Notidanidæ*).

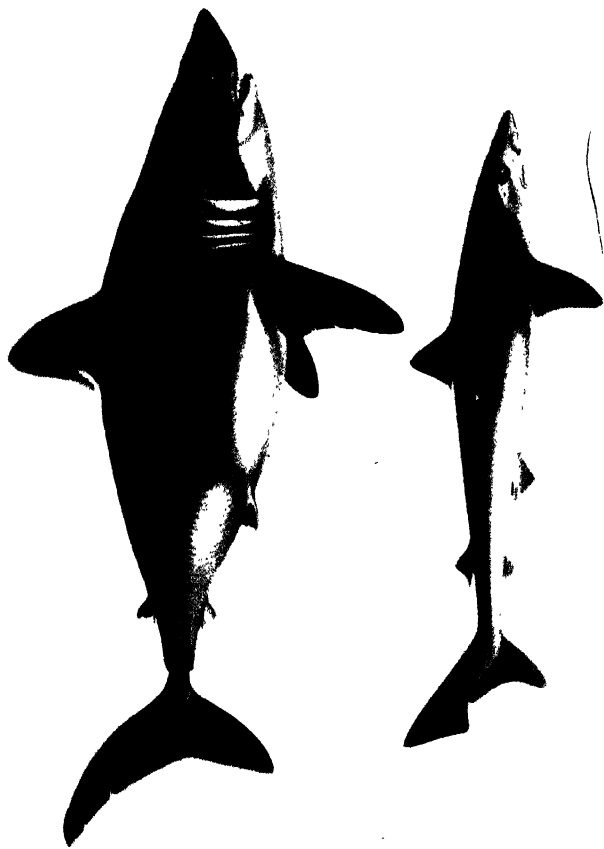
This family of sharks is distinguished by the following peculiarities. There is no nictitating membrane to the eye. The spiracles are small, situated on the side of the neck. There are six gill openings in the only British representative (*Notidanus griseus*), but in allied forms (*Heptanchus*) there may be seven. There is only one dorsal fin, which is spineless and situated opposite the anal. The caudal fin has a lower lobe; there is no pit at the root of the caudal. In the upper jaw the teeth consist of one or two awl-shaped pairs, followed by six broader ones which have one strong and several smaller cusps. The lower jaw has six comb-like teeth on each side, with smaller posterior teeth. This species is viviparous.



Pl. 128.

Electric Ray. (p. 329)

N 316.



Pl. 129.

Forbeagle, sp. n.

Pl. 317.

The Six-gilled Shark (Plate 121) is a species of large size, attaining a length of 26 feet. Inhabiting tropical and sub-tropical seas, it occasionally strays into British waters. Day gives five records for Great Britain, the largest being a specimen 26 feet 5 inches long taken at Polperro, Cornwall, in February, 1846. Since Day it has been recorded in Ireland by Scharff, who obtained a specimen 9 feet 4 inches long from Dugort, Achill Island; and in Scotland by Sim, who notes a fine female captured south-west off the Orkney Islands and brought into Aberdeen market in August, 1894. The stomach of this fish contained haddock and dabs. A few days later two other females were caught in the same locality; their stomachs contained Angler fish, Piked Dogfish and Plaice. Other Scottish records are four large specimens off Carloway, Lewis, in 1870-1, one off Lochbine, Mull, in 1887 (Anderson Smith), and one 9 feet 10 inches long caught off Skerryvore Lighthouse and landed at Tiree in 1896. Another Irish record is of a specimen 7 feet 4 inches long taken in May, 1913, at the mouth of the Kenmare River and presented to the Irish National Museum (Scharff). Also from the Irish Atlantic Slope in 1934 (Fraser-Brunner).

THE DOGFISHES (Scyllidæ).

The Dogfishes are coastal species of small size living on the bottom on crustacea and fish. There are three species found in British waters, which may be distinguished thus:

Upper edge of caudal fin smooth. Snout rounded.

Numerous small black spots on body.

Lesser Spotted Dogfish (*Scyllium canicula*).

Few larger black spots on body.

Nurse Hound (*Scyllium catulus*).

Upper edge of tail with row of small flat spines. Snout produced. Large black blotches on side of body.

Black-mouthed Dogfish (*Pristiurus melanostomus*).

In these Dogfishes there is no nictitating membrane to the eye. A distinct spiracle is present. There are two spineless dorsal fins, the first above or behind the pelvics. An anal fin is present. The mouth is on the lower surface of the body, with several rows of small teeth. All three species lay eggs in pairs in horny capsules.

The commonest Dogfish met with in British waters is the Lesser Spotted Dogfish (*Scyllium canicula*, Plate 131). Sometimes it is present in enormous numbers and is troublesome to line fishermen, since it takes their bait to the exclusion of other and more valuable fish. It is also frequently taken in herring nets in November and December. The females come close inshore for the purpose of spawning. The eggs, which are provided with a horny capsule, are laid in pairs (Plate 43). The female at the time the eggs are deposited swims round and round some object such as a bunch of seaweed, until the filaments of the egg capsule have become entangled. A pair of eggs, one from each oviduct, is laid at one time. The development lasts throughout the winter, the young fish being hatched out in the following spring.

The Lesser Spotted Dogfish is ubiquitous in the Irish Sea, and a haul of the trawl is rarely made without a few being caught. Occasionally large numbers are taken, notably on one occasion 400 were taken on the 20th September, 1904, in a small trawl in a haul of one hour's duration on the Lancashire Fisheries steamer near the Liverpool North-West Lightship.

The Larger Spotted Dogfish or Nurse Hound (*Scyllium catulus*, Plate 131) is much rarer in our waters, at any rate off the west coast and in the Irish Sea, where only a few specimens are taken each year in the trawl. It may easily be distinguished from the preceding species by its larger size and the much larger spots on the body. These fish are not much eaten. The writer has tried them, but it must be admitted the flesh has a coarse

flavour. Attempts have been made to market it under the name of "Flake."

Like all other omnivorous fish the dogfish are infested with parasites.

The third species, the Black-mouthed Dogfish (*Pristiurus melanostomus*, Plate 122) is a more southern species than the others, since though it is common enough in the Mediterranean it rarely occurs in British waters. Day gives three records from British and one from Irish waters. Since Day's time it has been recorded in Ireland by Spottiswoode Green, who caught a young one in 150-fathom water off the south-west coast in July, 1889; and by Holt and Calderwood in the trawl in 144 fathoms off Achil Head in April, 1891. Sim records it in Scottish waters off Aberdeen, where one was taken in the trawl 4 miles offshore in November, 1898. This was a female with two eggs in the oviduct.

The Lesser Spotted Dogfish attains a length of from 20 to 28 inches, the Nurse Hound from 40 inches to 5 feet and the Black-mouthed Dogfish from 32 inches to 3 feet.

SPINY SHARKS (*Spinacidæ*).

A family of surface-living sharks distinguished by the presence of two dorsal fins and the absence of an anal fin. The mouth is only slightly arched. There is a long, deep, straight oblique groove on each side of the mouth. Spiracles are present; the gill openings are narrow. The pectoral fins are not notched at their origin. There is no nictitating membrane covering the eye. This family of sharks includes both rapid and powerful swimmers and also more or less sedentary and sluggish species. The former group have the upper lobe of the tail-fin well developed, so that it acts as a propeller.

In this group the eyes, nostrils and sensory organs are well developed. Like most predatory species they are of wide

distribution. Only one species, the Piked Dog, is at all common in British waters ; occasionally, as in the English Channel, it rivals the Lesser Spotted Dogfish in abundance.

Seven species of this family have been recorded from British seas, each species belonging to a distinct genus. They may be separated by the following characteristics :—

1. Each dorsal fin with a spine ; a fold of the skin on each side of the abdomen. Humantin (*Centrina salviani*).

Each dorsal fin with a spine ; no lateral fold of skin.

Teeth equal in both jaws, oblique.

Picked Dogfish (*Acanthias vulgaris*).

Upper teeth erect, with a single cusp, lower oblique.

Centrophorus (*Centrophorus calceus*).

Upper teeth erect, tricuspid, lower oblique.

Spinax (*Spinax niger*).

2. Dorsal fins without spine ; the first well in front of the pelvics.

Lower teeth oblique, quadrate with horizontal cutting edges. Greenland Shark (*Lamargus microcephalus*).

Lower teeth erect, triangular.

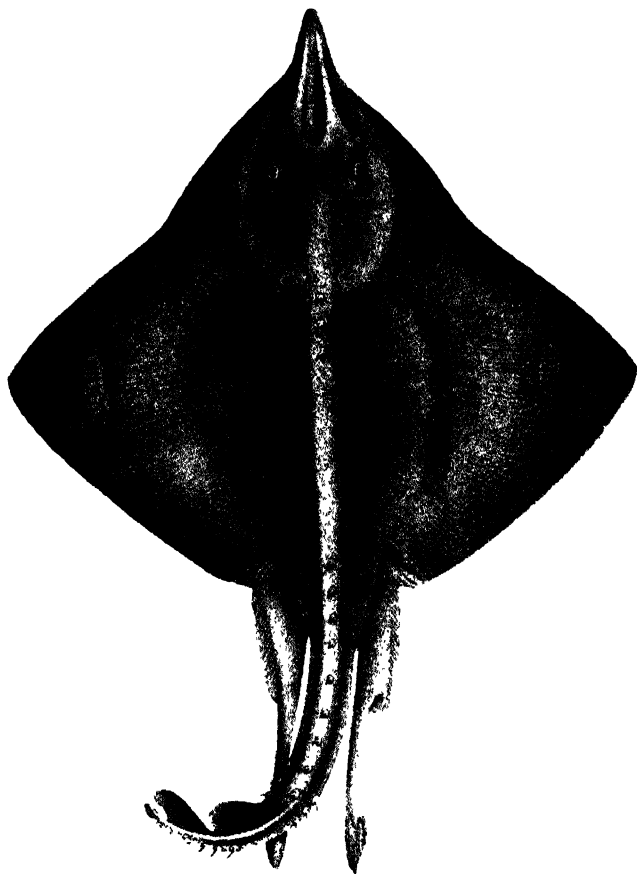
Darkie Charlie (*Scymnus lichia*).

Dorsal fins without spine ; the first opposite the pelvics.

Spinous Shark (*Echinorhinus spinosus*).

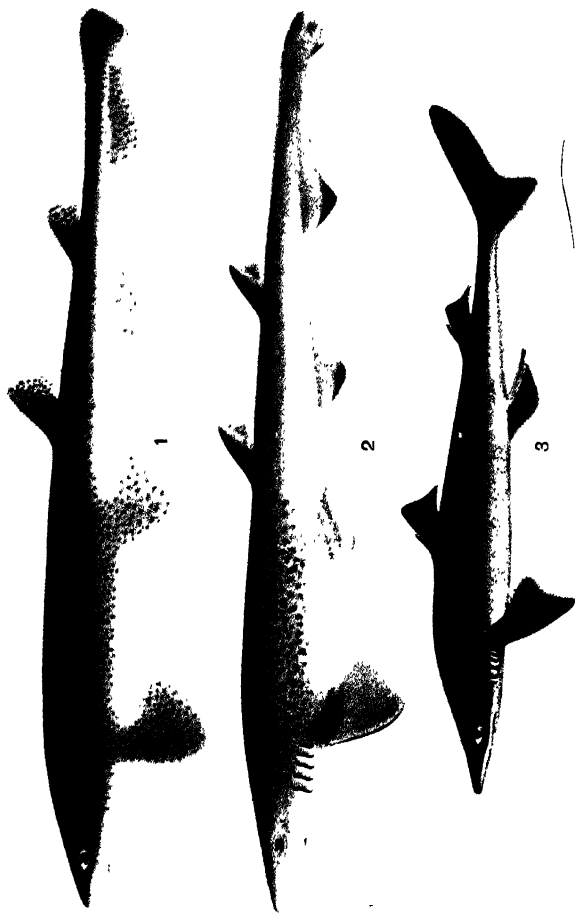
The Humantin (*Centrina salviani*).

In this shark each dorsal fin has a strong spine. The spiracles are wide and placed immediately behind the eye. The gill openings are narrow. The mouth is narrow, with a deep lateral groove. The teeth in the upper jaw are slender and conical, forming a group in front of the jaw ; in the lower jaw they are rather small, triangular and erect, with their edges finely serrated. A fold of skin runs along each side of the abdomen as well as along the back between the dorsal fins.



Bottle-nose Ray. (p 355).

A 320.



Pl. 131.

1. Lesser spotted Dogfish. 2. Larger spotted Dogfish p. 317
3. Pinked n. s.

V 321.

It is a southern species occurring in the Mediterranean and off the Portuguese coast. Cornish records one specimen captured by the trawl in 26 fathoms near the Wolf Lighthouse off the Cornish coast. It has also been recorded from Norway. This species is viviparous. A closely allied species, new to the British Fauna, is described in the Appendix (p. 373).

The Picked Dogfish (*Acanthias vulgaris*).

This is the only representative of the Spinacidæ which is at all common off the British coasts. It is easily distinguished (Plate 131) from the other British Dogfish by the presence of a spine in front of each of the dorsal fins, from which it derives its name of Piked or Picked Dogfish. The teeth are rather small and the same in both jaws; their point is so much twisted aside that the inner margin forms the cutting edge. The spiracles are fairly wide and situated immediately behind the eye. The gill openings are narrow.

This species has a wide distribution, being found only in temperate seas of the northern and southern hemispheres. This fish is viviparous. Pairing takes place in autumn, the young being born in the following spring, at which time the females assemble close inshore in water from 3 to 6 fathoms in depth. The young when born measure from $8\frac{1}{2}$ to 10 inches in length; they remain inshore during the first summer, and are not infrequently taken at this stage in inshore waters, though they are less abundant than the Common Dogfish. They migrate outwards from the coast in winter, but there is reason to think that this migration is not extensive in the first winter. Like many other Dogfish the Piked Dog keeps together in shoals, moving towards the coast in summer and outwards again in winter.

The young when born are vigorous and active fish. A female of this species when opened was found to contain five

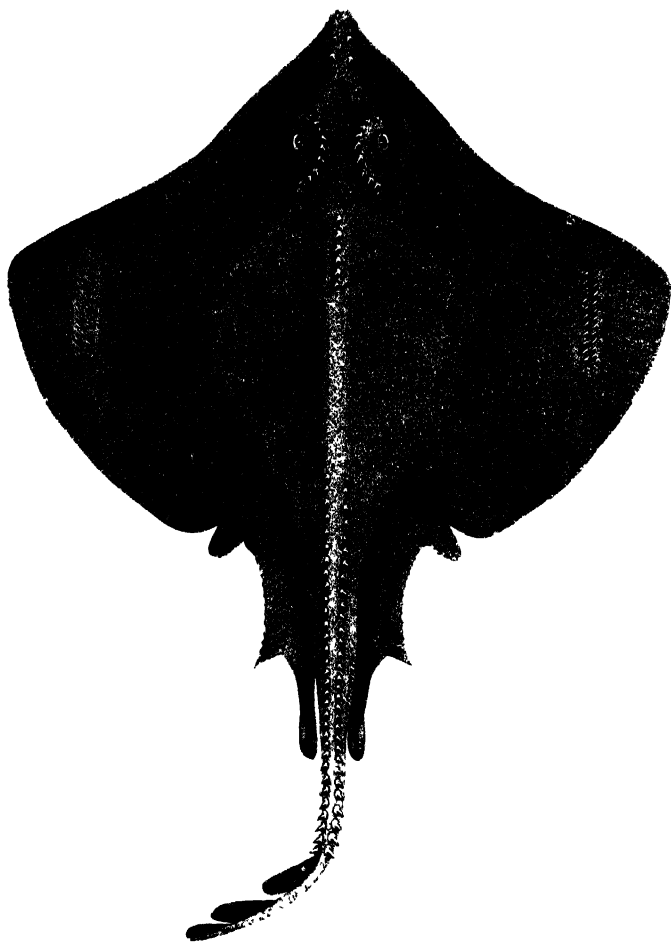
young, which, when put into a bucket of sea water, swam about for some hours.

The Piked Dogfish attains a length of at least 4 feet. It, together with other dogfish, is not much esteemed as food, though it is prepared for some of the Lancashire markets by having its fins removed and the bulk of the skin as well, so that it is not easily identified.

There is a curious mistake in Day with regard to this fish. He says, "This fish is dried and eaten on many parts of our coasts; it is rather strongly tasted, but largely employed by the poor as food in the Hebrides, and sold as Darwin salmon." The truth is that this fish and allied species are sold rather more readily in Darwen, a neighbouring township to Blackburn in Lancashire, than in other districts, and is retailed there as Darwen (pronounced Darren) salmon.

Dogfish are classified together in the official fishery statistics. In 1923 the weight landed in England and Wales was 95,979 cwt., valued at £49,980. The Piked Dogfish is one of the most destructive species met with in British waters. It follows the shoals of herring and haddock and causes great damage to the fisheries by devouring the fish, either in the drift nets or on the long lines.

According to Couch as many as 20,000 Piked Dogs have been taken in the Channel in one haul of the seine. Apart from its sale as food, other attempts have been made to utilise the Piked Dog commercially. In Canada, under the auspices of the Government Fisheries Department, three reduction works have been erected for the preparation of oil and fish-meal and guano from this fish, and in the season of 1910, lasting from August to the beginning of November or December, 2,800 tons of Piked Dog were dealt with, yielding 300 tons of fish-meal and 20,000 gallons of oil. More recently the fish has been proved to be less abundant. In the United States the fishermen of Boston and Gloucester are said to catch 27 million Piked Dog-



Pl. 132

Shagreen Ray. (p. 337).

1 322.



Pl 133.

Common Skate. (p. 334)

Y 323.

fish every year of an average weight of 7 lbs. The damage caused to the Massachusetts fishermen by this fish is estimated at 400,000 dollars annually. The liver of the Piked Dog is estimated to contain 50 per cent. of oil, so it should be worth exploiting.

Centrophorus (*Centrophorus calceus*).

This small shark is occasionally caught and landed by British trawlers fishing the western and south-western grounds. Though a Mediterranean and Portuguese fish, it strays as far north as the British Isles.

It may be distinguished easily by the long spatulate snout, the distance between the nostrils being less than one-third of the length of the portion of the snout in front of the mouth. The scales are very small, tricuspid, and they give a velvety appearance to the skin. The lower angle of the pectoral fin is rounded; the length of the bases of the two dorsal fins without the spines is nearly equal, and one-half of the distance between them. The extremity of the pelvic fins is below the middle of the second dorsal fin.

This species has been definitely recorded off the west coast of Ireland by Schmidt. A closely allied species, *Centrophorus squamosus*, was recorded twice by Holt and Calderwood from Irish waters in 1895. The first specimen was taken off the coast of Mayo in 250 fathoms. *Centrophorus squamosus* differs from *Centrophorus calceus* in that the scales are leaf-shaped, with a strong median keel, quite free and inserted in the skin by a short stalk. The snout is also not so prolonged in *Centrophorus squamosus*. Fraser-Brunner records 10 specimens of *C. squamosus* from the Irish Atlantic Slope at 200 fathoms (1935). Also 2 specimens in Lat. 50° 35' N., Long. 13° 3' W. The closely allied shark *Scymnodon ringens*, Bocage, is recorded by Holt as having been captured off the Tearaght Rock, County

Kerry, Ireland, in 215-315 fathoms. *Scymnodon* differs from *Centrophorus* in that its lower teeth are more or less erect and triangular, while those of *Centrophorus* are oblique with trenchant inner edges. A second specimen of *Scymnodon*, a female $4\frac{1}{2}$ feet long, was recorded by Sim in 1901 from Aberdeen fish market. It was captured by line fishermen off Barra Head, Outer Hebrides, in August.

Spinax (*Spinax niger*).

This shark, which from its dark skin and general appearance is confused by our trawlers with the somewhat similar "Darkie Charlie" (*Scymnus lichia*), may be distinguished at once from the latter species by the fact that it possesses a spine in front of each of the dorsal fins. Like *Scymnus* it is frequently landed at Milford and other west-coast ports whose trawlers fish the western grounds. There is a specimen in the British Museum from the coast of Jutland, so there can be little doubt that it occurs occasionally in British seas, although really a southern species ranging from the Mediterranean to the West Indies. According to Collett it is found off the Norwegian coast. This is a much smaller species than *Scymnus*. It is characterised by the tricuspid, erect teeth in the upper jaw, and the fact that the teeth in the lower jaw have the tip so much turned to one side that the inner margin forms the cutting edge. The spiracles are wide and on the upper surface of the body. The first dorsal fin is shorter than the second, and the spine on the second dorsal is longer and stronger than that on the first.

Meek gives a record of *Spinax niger* from the Pentland Firth in August, 1901, and Fraser-Brunner records numerous examples from the Irish Atlantic Slope in 1935.

Off the Icelandic coast this species attains a length of 3 feet. It is viviparous, the female giving birth to from ten to twenty young, usually in July or August.

The Greenland Shark (*Læmargus microcephalus*).

In the Greenland Shark (Plate 125) all the fins are small. The dorsals are somewhat similar in size, the first being considerably in advance of the pelvics; the pelvics are nearly opposite the second dorsals. The mouth is transverse, with a deep groove running posteriorly from its angle. The nostrils are near the end of the snout. The upper teeth are small, narrow and conical; the lower teeth, which are numerous, are in several series, the tip turned so much to one side that the inner margin forms a cutting edge. The spiracles are of moderate width. The skin is uniformly covered with small tubercles.

The Greenland Shark is a northern fish of which the British records are fairly numerous. It is reported to be a sluggish species. Scoresby says that it is a determined enemy of the Whale, biting great lumps of flesh from its body. This, of course, only refers to the dead whale. The writer has never seen this species in the British Isles, but in the Faroe Islands it is commonly seen in the neighbourhood of the whaling stations. In the summer of 1921 the writer observed it feeding at dusk on the offal and fragments of flesh at the whaling station of Thorsvig in the Faroes. It appeared to be solitary in its habits.

The Greenland Shark attains a length of 15 feet. It is stated by some authors to be viviparous, producing four young at a birth. On the other hand, Lutken says it deposits its numerous soft globular eggs, devoid of protective colouring, in the soft mud at the bottom of the deep sea.

In the nineteenth century there are about twenty records of this species from British waters. These are chiefly from Scottish waters, from the Hebrides and Orkneys, but it has been recorded as far south as Sheringham, also in Suffolk waters and on the Dogger Bank. The largest recorded by Day was 14 feet long and 6½ feet in girth, was captured at Aberdeen in December, 1880, and is now in the Aberdeen University

Museum. The largest recorded since Day's time in British waters was a female 21 feet long, weighing $27\frac{1}{2}$ cwt., taken in January, 1895, 25 miles north-east of May Island.

According to Calderwood the Greenland Shark is not uncommon in Scottish waters. There are two records for 1885, one for January, 11 feet long, taken 8 miles south-east of May Island by a trawler; the other, 5 feet long, caught by line fishermen shortly after the above. Another 10 feet long was stranded near Burghead in February, 1902 (Taylor).

From 1883 to 1893 no fewer than 120 specimens of this species were landed at the Aberdeen market, of which 89 were females. The largest male was 11 feet 3 inches long, the largest female $15\frac{1}{2}$ feet.

The jaws of this shark are often seen in ethnographical collections, being used by the Eskimo as a "tiara" headdress.

"Darkie Charlie" (*Scymnus lichia*).

This shark, together with *Spinax Niger* unquestionably comes at times within the limits of British waters.

It is distinguished by the two short dorsal fins without spines, the first being at a considerable distance from the pelvics. There is no anal fin. The skin is uniformly covered with minute scales. The mouth is ventral, transverse, with a deep straight groove at each angle. The nostrils are at the extremity of the snout. The upper teeth are small and pointed; the lower much larger, dilated, erect, triangular and not very numerous. In observing the teeth of sharks, one tooth at least should be carefully detached and examined with a hand lens, as the teeth are important in distinguishing the various species. There is no nictitating membrane in the angle of the eye. The spiracles are wide and behind the eye. The gill openings are narrow. According to Fraser-Brunner this fish is common off the Irish Atlantic Slope in 200 to 350 fathoms.

This shark occurs chiefly in the western parts of the Mediterranean and off the Portuguese coast. It is viviparous.

The Spinous Shark (*Echinorhinus spinosus*).

This shark (Plate 125) is most readily distinguished by the two dorsal fins, which are spineless, situated far back and close together, the first being opposite to the pelvic fins. The spiracles are small and behind the eye. The mouth is crescent-shaped, with a well-developed labial groove. The teeth in both jaws are flattened from side to side, with smooth cutting edges, two cusps and the point outwardly directed. The nostrils are midway between the mouth and the end of the snout. The skin has scattered large round tubercles, which are prickly, leaving a scar when detached. From the presence of these prickly tubercles the name of Spinous Shark is derived.

The pectoral and caudal fins are feebly developed. The body of this species is short and bulky, and it is obviously a ground shark. It attains a length of 9 feet and a weight of 400 lbs.

The range of this species is from the Cape of Good Hope to the Mediterranean, and the south coast of England to the North Sea. Day records some thirty specimens in British waters between 1828 and 1882. The largest recorded was a female 9 feet long, containing seventeen eggs, taken on a conger line on the 1st January, 1869, off the Eddystone. Inside it were several Dogfish some 3 feet in length.

Its breeding-place and home are in the North-East Atlantic.

There are a number of records of this species in British waters subsequent to Day. Two were captured by the trawl off the east coast of Scotland: one off Slains in August, 1883; the other, 5½ feet long, 24 miles off Buchan Ness in August, 1899.

THE MONK-FISH FAMILY (Rhinidæ).

The family of the Rhinidæ is represented in British waters by one species only, the Monk or Angel Fish (*Rhina squatina*, Plate 127). This family is characterised by a body-shape which is intermediate between the Sharks and the Rays. The head and body are depressed, that is, flattened horizontally. There are two dorsal fins devoid of spines and situated in the caudal region of the body. There is no anal fin. The pectorals are large, prolonged forwards and laterally, but are not attached to the head. The spiracles are wide and situated some distance behind the eyes. The mouth is anterior; the teeth conical, pointed and far apart. The colour is brownish-grey, with darker blotches and irregular white lines and spots.

The solitary British representative of this family is the Monk Fish, which is so called on account of the resemblance to a cowl on its head. It is also known as the Angel Fish, or from its shape the Fiddle Fish. The Monk is of cosmopolitan distribution and occurs all round our coasts. In the winter it lives offshore in deep water, migrating towards our coasts in spring, when it is frequently taken in the trawl. The monk is viviparous, producing about twenty young at a birth. It is said to attain a length of 8 feet, but the largest the writer has seen in the Irish Sea only measured a little over 4 feet.

THE ELECTRIC RAYS (Torpedinidæ).

In this family the body is a broad, smooth disk. The tail has a rayed dorsal and caudal fin and a longitudinal fold of skin on each side. The anterior nasal valves are confluent, forming a quadrangular flap or lobe. The chief characteristic of these fish is, however, the presence of an electric organ consisting of vertical hexagonal prisms and situated between the pectoral fins and the head. Each prism is subdivided into cells by

delicate transverse septa, and each cell is filled with a clear jelly-like fluid. The ends of the prisms are in contact with the skin above and below. Lining each cell there is a layer of tissue on which the termination of the nerves branch, the whole apparatus being highly nervous. Hunter counted 470 prisms in each battery of the Common Electric Ray (*Torpedo marmorata*, Plate 128). The nerves supplying the electric organs are enlarged, being as thick as the spinal cord: they are known as electric lobes. The Electric Ray gives an electric shock voluntarily, either in self-defence or to kill or stun its prey. The frequency of the shocks is very high, amounting to 150 per second. When the electric organ is run down, the fish requires a period of rest, feeding and recuperation before the electric property is again manifested.

The Electric Ray ranges from the Cape right through the Eastern Atlantic to British waters. It is by no means a rarity off our coasts, Day giving many instances of its occurrence, and there are many records subsequently. In the Irish Sea one or more specimens are taken nearly every year near Pwllheli on the Carnarvonshire coast; and the Hoylake trawlers who fish those grounds know the Electric Ray well, and tell me that they get a few specimens every year in their trawls. This Ray is viviparous. A second species, with conspicuous white spots on the body (*Torpedo marmorata*), may occur in British waters, but the existence of British specimens is at present doubtful.

A female of *Torpedo nobiliana* was caught by a trawler in Dublin Bay late in 1905; it measured 2 feet 9 inches long, 1 foot 8 inches broad and weighed 25 lbs. The writer caught one in the trawl in Carnarvon Bay off Llanddwyn Island in August, 1924, measuring 2 feet 4½ inches across the disk and weighing 43 lbs. In Scotland it has been recorded by Sim in herring nets in Wick Bay; in the trawl off Wick in December, 1894, a specimen 3 feet 7 inches long and 2 feet 8 inches broad; and another in the Moray Firth in April, 1900.

The largest known from British waters is in the Hamburg Museum. This fish, which is between 5 feet and 5 feet 4 inches long and weighed about 110 lbs., was caught by a trawler to the west of the British Isles.

PRISTIDÆ.

The Saw-fish (*Pristis antiquorum*).

In the Saw-fish the body is depressed and elongate, intermediate in shape between the Sharks and the Rays. The tail is long, strong and muscular. The pectoral fins, which have their anterior margins quite free, do not extend to the head. The chief characteristic of this family of fish is that the snout is produced into an exceedingly long process, armed on either edge with a series of strong teeth. In all fish of the Ray family there are tubular processes of the cranial cartilage. These tubes, which in our rays are short, are in the Saw-fish much elongated and strengthened with a bony deposit. These hollow cylindrical tubes, of which there are usually either three or five, encrusted with bone, form the basis of the structure of the "Saw," which, of course, is a weapon of offence and enables the fish to attack and tear its prey before it is seized by the small teeth within the mouth. These jaw teeth are small and obtuse. The dorsal fins are devoid of a spine, the first being situated opposite or close to the base of the ventrals.

Several species are met with in tropical waters, a few wander into sub-tropical seas, but only one (*Pristis antiquorum*) has hitherto been recorded in British waters (Sir Thomas Browne). This record is not accepted by Boulenger.

THE RAYS (Rajidæ).

Skates and Rays are bottom-living fish of large size usually found in temperate and tropical waters at intermediate or even at great depths.

In the Rays the body is depressed and broad, of circular or rhomboid form. Tubercles or spines are usually present. The pectoral fins extend to the snout. There is a longitudinal fold of skin on each side of the tail. There is no serrated caudal spine and no electric organ.

The British Rays and Skates may be divided into—

Long-snouted species, of which there are five ; and

Short-snouted species, of which there are eight.

The long-snouted species may be separated by the following characters :—

Skin smooth, under-surface bluish colour.

The Skate (*Raja batis*).

Greyish above, pure white below. A patch of spines on pectoral in male.

White Skate (*Raja alba*).

Snout very long ; greyish-brown above, under-surface grey, etc.

Long-nosed Skate (*R. oxyrhynchus*).

A patch of spine on each pectoral. No spines along mid-line of tail. Upper surface covered with minute spines.

Ten or twelve large spines round upper margin of orbit.

Shagreen Ray (*R. fullonica*).

Brown above, white beneath. No spines on middle of back, but many little asperities on the disk.

Flapper Skate (*R. macrorhynchus*).

There are eight short-snouted species, which are thus distinguished :—

Dorsal surface rough and spiny. Tail with numerous strong spines. Upper surface brownish and marbled.

Thornback Ray (*R. clavata*).

Upper surface brown and covered with numerous black spots.

Spotted Ray (*R. maculata*).

Upper surface fawny with numerous black spots.

Blonde Ray (*R. brachyura*).

Body rhomboidal. Pale brown. Upper surface covered with large thorny spines with stellate bases.

Starry Ray (*R. radiata*).

At base of pectoral fin on each side a large black blotch with broad yellow lines in centre.

Cuckoo Ray (*R. circularis*).

Upper surface light grey with numerous white bands and spots.

Painted Ray (*R. microcelluta*).

Uniform in colour, with small white blotches.

Sandy Ray (*R. miraletus* or *R. nœvus*).

Prettily marked. Spotted like a leopard.

Undulate Ray (*R. undulata*).

All British Rays lay eggs which are enclosed in a horny capsule. Considerable advances in our knowledge of our rays have been recently made (1922) by Clark, who investigated the egg capsules and young of nine different British species, and in some cases succeeded in hatching the young fish from eggs kept alive in the aquarium of the Marine Biological Association at Plymouth. In the Rays the fertilisation of the eggs is internal, that is, before they have left the body of the female parent. This takes place in the upper reaches of the oviduct, the egg becoming covered with the horny capsule secreted by a shell gland on its way to the exterior, which it reaches by way of the cloaca.

Most of the egg capsules studied by Clark were obtained from cloaca of adult fish landed on the fish quay. They were transferred as rapidly as possible to the tanks in the laboratory, where their subsequent development was traced. Although the mortality in the eggs was high, results of great interest were recorded; but of course the eggs developed under somewhat abnormal conditions, since the temperature and salinity of water in the tanks were higher than in natural conditions. After about two months the albumen in the eggs is absorbed, the slits at the base of the horn are open, through which the young fish escapes into the surrounding water. Eggs of the Thornback Ray (Plate 14) were found quite easy to rear, as the development only took a few months. In the Common Skate (*Raja batis*)

development is slower and hatching of the embryos more difficult.

A large blonde Ray was caught by the trawl and placed alive in a tank, the bottom of which had a thick covering of gravel and pebbles. In the same tank was a large cod. Egg capsules began to be deposited on the 12th April, 1922, and continued to be extruded singly at intervals. At first, although the egg capsules were seen extruding from the cloaca of the fish, none could subsequently be found, and it was thought they had been devoured by the cod. But on raking over the gravel the egg capsules were found to be completely buried. The actual method of deposition was not observed. Generally one capsule would be followed immediately by another, after which the fish rested for about twenty-four hours, when another pair appeared.

Although the capture of female rays and skates in the trawl with eggs ready for laying is not uncommon, the capture of the egg with the young inside is a very rare occurrence.

The egg capsules of rays and skates when empty may often be picked up on the seashore. They vary in form and appearance in the different species, but they are always more or less rectangular, with the corners prolonged into hollow tubes or horns which may be drawn out into fine points but never have tendrils as in the Dogfish. Each horn is provided with a slit, closed in the early stages by a plug of albumen or a delicate membrane. There are always two long and two short horns; the embryo when hatched escapes usually through the slit between the long horns. The shell of the egg capsule becomes brittle on exposure to sea water, and unquestionably there is a circulation between the sea water and the internal fluid. The shell consists of several layers of closely packed fibres with longitudinal striation. Clark thinks that the aeration of the embryo during development is insufficiently provided for by osmosis through the shell wall, but that the slits referred to are adapted

for providing a circulation of the sea water for the respiration of the embryo.

The period of incubation varies considerably ; it is shortest in the Thornback Ray, from $4\frac{1}{2}$ to $5\frac{1}{2}$ months, and longest in the Bottle-nosed Skate, $14\frac{3}{4}$ months. The period is, of course, of that observed under the artificial conditions which obtained in the laboratory tanks.

The spawning period in most rays is probably prolonged, lasting through the greater part of the year. The size of the eggs shows great variation ; the smallest are those of the Cuckoo Ray, 63 by 36 millimetres ; the largest those of the Bottle-nosed Skate, 180 by 136 millimetres. The embryos of the rays are provided with branchial filaments, highly vascular and extremely delicate elongations of gill lamellæ, and these are thought to assist in the absorption of the albumen. They are also present in viviparous Elasmobranchs. The newly hatched fish differs considerably in character and shape from the adult, and undergoes definite post-embryonic changes.

The Skate (*Raja batis*).

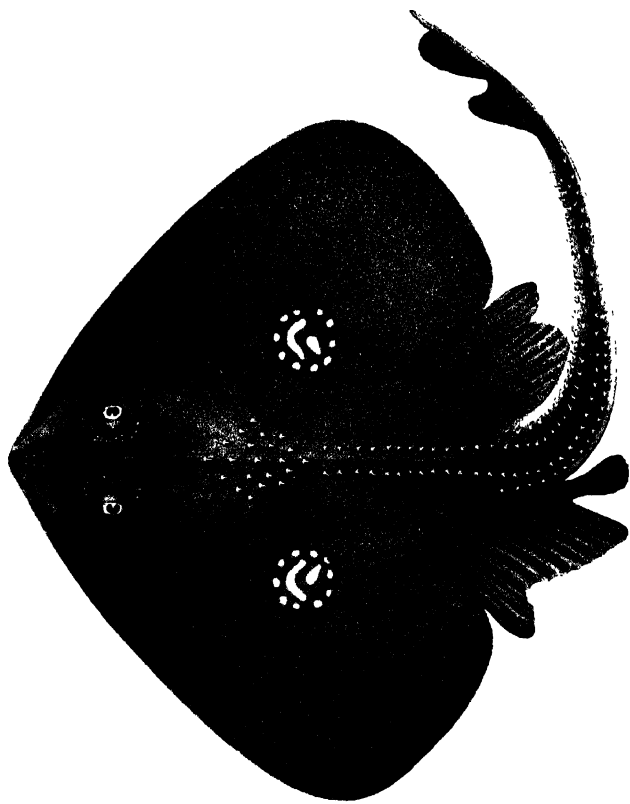
This species is the Common Skate (Plate 133) of our deep-sea fishermen, and is known to Lancashire fishermen as Bluet. In the Skates and Rays the gill openings and mouth are on the lower surface, so, as these fish generally lie on the bottom of the sea, they are provided with breathing holes or spiracles at the top of the head. The Common Skate is most easily distinguished from other members of the Ray family by its bluish-white under-surface, which is more deeply coloured than in any of the other species. It grows to a width of 7 feet, skates and rays being usually measured across the back at its widest part and the dimensions expressed as widths, not lengths. Common Skate are taken by the trawlers and long-liners in large quantities, and though the larger specimens are generally



Pl. 134.

Thornback Ray (male) (p. 138)

Y 334.



considered to be rather coarse, the smaller are of excellent taste. Fishermen, who are often good judges in these matters, consider the flesh of the skate to be superior to any of the other rays.

The Common Skate is of wide distribution, being found at varying depths all round the British Isles. It is a predacious species living on other fish, such as plaice, mackerel, cod and hake, and crustacea.

Skates and the different species of Ray are not separately classified in the official Statistical Returns of the Sea Fisheries, but are lumped together as "Skates and Rays."

Usually about one-half of our fishermen's catch of skates and rays comes from the North Sea, about one-quarter from the fishing-grounds to the south-west of the British Isles, the remainder in varying proportions from the north-west of the British Isles (15 per cent.), Iceland ($3\frac{1}{2}$ per cent.), Bay of Biscay and Morocco.

The Skates and Rays may be divided into shallow-water and deep-water species, or into northern and southern species. Of these, the Skate may be considered to be a denizen of shallow water and of northern regions.

The largest Skate of which the author has record was one landed at Grimsby from the Iceland fishing-grounds; it measured 9 feet 4 inches in length and 6 feet 7 inches in breadth.

The Bottle-nose Ray (*Raja alba*).

The Bottle-nose Ray (Plate 130) is a very large thick ray, with a moderately long and very sharply pointed snout. According to Holt the dorsal surface is generally destitute of large spines, except for the male sexual spines, which include not only the wing series, but also a group at the margin opposite the eyes. There are some spines present on the snout and the supra-orbital ridges. On the tail is a single median series,

extending some way on to the back, and a lateral sub-marginal series, which, if sometimes single, may frequently be complex. The ventral surface is generally smooth, except along the anterior margin of the disk which is occupied by a distinct border of spines and asperities. There are no black or grey markings of any sort on the ventral surface, which in large examples is dead white without any pigment whatever. This serves to distinguish it from the closely allied Common Skate (*Raja batis*). Young examples of the Bottle-nose Ray have a border of dark pigment on the ventral surface of the wings; the under side of the tail is dark. The teeth are pointed in both sexes. The egg purse does not differ greatly from that of the Common Skate.

The Long-nosed Skate (*Raja oxyrhynchus*).

The Long-nosed Skate is a deep-water fish of northern distribution, being found more especially in the deeper waters of the northern North Sea and off the Norwegian coast. It may easily be distinguished by the very elongated and pointed snout. The skin is devoid of large spines, but there are small ossicles scattered over both sides of the body. The colour is greyish-brown above and greyish beneath. This species must be regarded as one of the rarest of our skates, since it prefers deep water and therefore only rarely comes near our coasts. The writer has never seen it caught in the trawl in the Irish Sea. Holt records a female 50 inches long in 500 fathoms 30 miles off the coast of County Mayo in 1891, and other younger specimens in from 25 to 80 fathoms in the same neighbourhood. The Scottish Fishery Board records give two small specimens in deep water east of Arran, and one 51 inches long captured in the Clyde and brought to Girvan in February, 1900.

The Shagreen Ray (*Raja fullonica*).

This Ray (Plate 132) also belongs to the long-snouted species. Its snout, though cone-shaped and sharp, is nothing like as long as in the preceding species. The Shagreen Ray extends from France northwards to the north of the British Isles, making a seasonal migration inshore in the summer, since at that time it is caught by our trawlers in the North Sea along with the Starry Ray (*R. radiata*). It is a deep-water fish and must be regarded as rather rare, since Day only gives about half a dozen authentic records. The writer first recorded it for the Irish Sea, in a catch with the trawl from the Lancashire Fisheries steamer on the 26th May, 1905, in Carnarvon Bay, and again on the 15th February, 1911, off Redwharf Bay, Anglesea.

The Cuckoo Ray (*Raja circularis*, Couch).

The species described by Day under the name of *Raja circularis* includes two distinct forms, the Cuckoo Ray (*Raja circularis*, Couch) and the Sandy Ray (*Raja miraletus* or *R. nævus*).

The Cuckoo Ray (Plate 135), which is the species figured by Day as *R. circularis*, is easily distinguished by the large round black blotch at the base of the pectoral fin in each side. This blotch has broad yellow lines in the centre and usually yellow spots near the margin. In the North Sea the Cuckoo Ray is common, descending to over 350 fathoms off the coast of Norway, or even to 500 fathoms in the Atlantic. It is common enough in the Irish Sea, and is frequently taken in the trawl on the Lancashire Fisheries steamer.

The Painted Ray (*Raja microcellata*).

The Painted Ray (Plate 137) may be distinguished by the short snout and the coloration. The upper surface of the

body is light grey, with numerous white bands and spots. Day gives its range from the southern shores of England to the coasts of France. A fish of moderate depths, this species was first recorded in the Irish Sea by the writer in 1905. Previously Holt had written in 1902: "It is quite likely that you have *R. fullonica* and *R. microcellata*, the former in deep water to the north, the latter stowed away in some isolated bay." In both respects Holt was correct: the reference to *R. fullonica* has been given above, while the Painted Ray was taken by the writer in the trawl on the Lancashire Fisheries steamer 2 miles off New Quay (Cardigan) Head on the 25th May, 1905, again off Llanon (Cardiganshire) on the 10th November, 1905, and off New Quay Head again on the 27th April, 1908, and August, 1924. In 1891 fourteen examples were taken by the Irish Survey in Blacksod Bay, Loughrosmore and Boylash Bays, in from 5 to 19 fathoms. According to Holt it is extremely local in distribution off the Irish coast, and this corresponds to the writer's experience off the Welsh coast.

The Sandy Ray (*Raja nævus* or *miraletus*).

The Sandy Ray is similar to the Cuckoo Ray, but the body is of almost uniform colour, with some small white blotches. The alar ocelli are absent. This fish is common off Plymouth (Clark), and is occasionally taken in Clew Bay (Farran). One was also taken in N. Wales water May, 1927.

The Thornback Ray (*Raja clavata*).

The Thornback Ray (Plate 134) is the commonest and most widely distributed of the rays found in British waters. A short-snouted species, it may be recognised by the four rows of hooked spines on either side of the wing in the male, by the general coloration, which is brownish or greyish and marbled all over, with opaque white under-surface, and by the teeth, which are

large and in the female flat and oblique in both jaws; in the males there are about 40 rows, the outer ones lozenge-shaped, the inner ones conical. The Thornback Ray migrates inshore in summer and offshore in winter. It ranges from Madeira to Trondhjem, and is also found in the Mediterranean and Black Sea. In the Baltic it is scarce. In the Irish Sea the Thornback Ray is by far the commonest species, and is caught in the trawl in large numbers at all times of the year.

The Spotted Rays (*Raja maculata* and *R. brachyura*).

The Spotted Ray (Plate 138), may be recognised by the rich brown colour of the upper surface of the body, which is covered all over with round black spots. The Spotted Ray extends from the British Isles to the Mediterranean. Its migration and spawning are similar to those of the other rays. A closely allied species is the Blonde Ray (*R. brachyura*) light fawn to brown in colour with numerous small black spots.

The Starry Ray (*Raja radiata*).

The upper surface of the body in this Ray (Plate 139) is provided with large spiny plates or buckles, in addition to spines on the pectoral fins, head, back and tail. The females are larger than the males and more spiny. It is a northern species and a deep-water form, ranging from Spitzbergen, Bear Island, along the Norwegian coast down to British waters.

There are many records for Scottish waters; according to Sim it is quite abundant off the Aberdeen coast, particularly from the beginning of May to the end of July. In the Irish Sea it has been taken in the fishing weirs in the Menai Straits, a specimen being secured there in August, 1904.

The Flapper Skate (*Raja macrorhynchus*).

This skate (Plate 140) is rather rare in British waters. According to Day it has been taken at Plymouth, in Dublin Bay and in the Firth of Forth. Trawling records of the Scottish Fishery Board research steamer give 37 examples from the Firth of Forth between 1886 and 1895. This species is very rare in the Irish Sea. It differs from the Common Skate by its white under-surface, by its more elongate snout and the many little asperities on the disc. It is common on the French coast and in the Mediterranean. Modern opinion regards this species as a variety of the Common Skate.

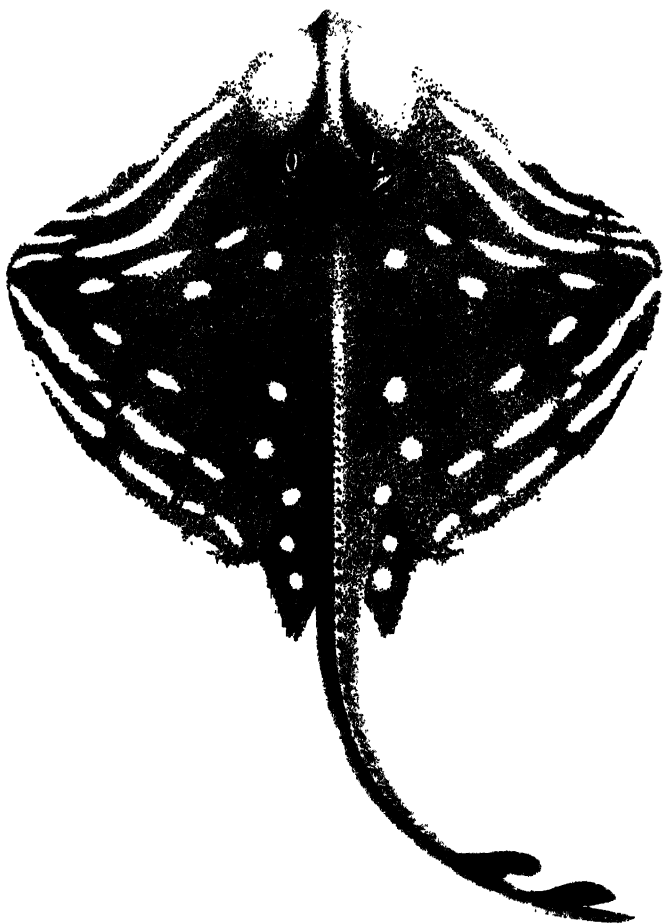
The Undulate Ray (*Raja undulata*).

This species was formerly not regarded as belonging to the British Fauna, but Tate Regan recorded a specimen from Hastings in February, 1913, mentioning at the same time that examples were known from Rye Bay, Sussex and Cornwall. A specimen was also landed from the Channel by the trawler *Herring Searcher* at Yarmouth in March, 1924. This species of Ray is prettily and unmistakably marked, being spotted like a leopard. The colour above is brown, orange or yellow, with blackish or brownish undulating stripes usually margined with small white spots, with larger spots scattered on the disk. The outer pectoral angle is rounded and the body smooth. It ranges from the Mediterranean to the neighbouring parts of the Atlantic. Tate Regan says, "On account of its characteristic markings it is difficult to believe that it occurs regularly on our southern coasts and has been previously overlooked, and the only alternative is to suppose that it has extended its range to the coast of Sussex only in the last few years." According to Clark this species is not uncommon on the outer



Pl. 136.

1. Sea Lamprey. 2. Lampern. 3. Brook Lamprey. 4. *Ammodontes maculatus* (Pl. 343). Z 343.



Pl. 137.

Painted Ray. (p 337)

Z 341

fishing-grounds of the Channel off Plymouth, where two egg capsules were obtained in July, 1920. The capsule is very similar to that of the Spotted Ray, but is larger and more robust.

THE STING RAYS (Trygonidæ).

The Sting Rays (Plate 141) are fish in which the pectoral fins are continued forwards to the end of the snout. In general appearance they resemble the ordinary rays, from which, however, they are easily distinguished by the presence of a long, strong, serrated, arrow-shaped spine on the tail, which is itself very long. This spine replaces the dorsal fins, which are absent. Inhabitants of tropical seas, the Sting Rays are as numerous as the ordinary rays. The spine is a weapon of defence and is capable of inflicting a lacerated wound which may become poisoned, as the mucus possesses poisonous properties. The spines are shed periodically, becoming replaced by others growing behind the one which is shed. The Sting Ray is viviparous.

The name Sting Ray is derived from the spine on the tail. A large number of species are known in tropical seas, one of which (*Trygon pastinaca*) wanders into British waters. This Sting Ray is of very wide distribution, extending from British coasts to the east coast of North America, and through the Atlantic and Indian Oceans to Japan.

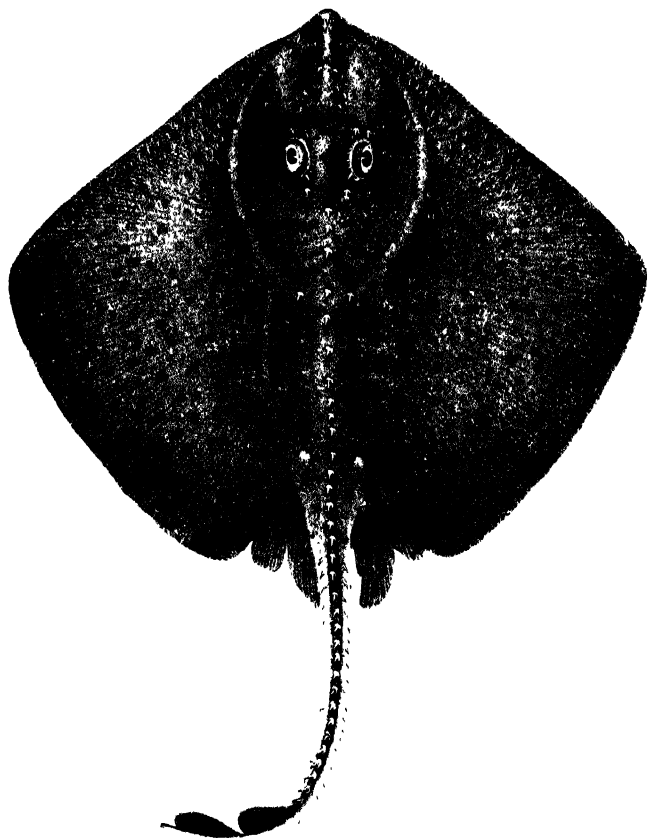
The Sting Ray makes its appearance in our waters with some degree of regularity every autumn, and is said to be common on our south coasts as far north as the Thames on one side and the Bristol Channel on the other. Day gives a number of records, the largest specimen being $3\frac{1}{2}$ feet long, weighing 56 lbs., caught at Yarmouth in 1869. Since Day's time it has been recorded by Holt, two specimens being taken in the trawl 20 miles off Plymouth in January, 1898; by Fulton in 1904. A specimen was caught in the trawl 28 miles off Montrose in

November, 1887 (Sim), and another $14\frac{1}{2}$ inches long and 6 inches broad off the Isle of May in December, 1897 (Clarke). Meek records one caught 6 miles off Cresswell in December, 1897, and others in October, 1904, off the Tyne in 40 fathoms, and October, 1906, in $28\frac{1}{2}$ fathoms off St. Mary's Island.

THE EAGLE RAYS (*Myliobatidæ*).

In this family the pectoral fins are greatly developed, so that the disc is very broad. These fins do not, however, extend on the sides of the head, which is free. They reappear at the end of the snout as a pair of detached head fins. These fish, which attain an enormous size, are inhabitants of tropical seas and are common in the Bay of Bengal. These are surface-living species of wide distribution, two of which, the Eagle Ray and the Horned Ray, drift occasionally into British waters. The Eagle Ray (*Myliobatis aquila*) is distinguished by its hexangular, large, flat, tessellated teeth. These in the middle of the jaws are much broader than long; there are several narrower series on each side. The tail is very long and thin and provided anteriorly with a dorsal fin, behind which is a serrated spine. The Eagle Ray is viviparous. The flesh is said to be of medium quality.

The Eagle Ray has a wide range, extending through the Atlantic and Indian Oceans to Australian seas. It is also taken in the Mediterranean. Day gives about a dozen authentic records for British waters; the largest specimen was one taken at Torbay in November, 1883, measuring $34\frac{1}{2}$ inches across and $26\frac{3}{4}$ inches long, excluding the tail. There are four records for the Irish Sea, all in Liverpool Bay. Since Day's time the Eagle Ray has been recorded four times off Aberdeen by Sim: in November, 1887, one was taken in the trawl 28 miles off Aberdeen; another in November, 1899, in Aberdeen Bay; a



Pl. 138.

Spotted Ray. (n. 339).

Z 342.



third 8 miles off Aberdeen in November, 1901; and a fourth 25 miles off Buchan Ness in January, 1902.

All these specimens were females. It has also been recorded by Cunningham, 1895, and by Holt in January, 1898, a specimen 34 inches across the disc being taken by trawl 320 miles off Plymouth.

There is one record of the Horned Ray (*Cephaloptera giornæ*) from the south coast of Ireland (1830). This species is recognised by the head having on either side a horn-like projection supported by fin rays. The teeth are very small, flat or tuberculated and in many rows. The tail is very slender and long, with a dorsal fin between the pelvics. A spine may be present or absent.

Cephaloptera is viviparous. The British Museum possesses an embryo 5 feet broad, weighing 20 lbs., which was taken from the mother, a fish measuring over 16½ feet in breadth.

THE CYCLOSTOMATA.

This sub-class comprises fish of primitive type in which the skeleton is cartilaginous, devoid of limbs, jaws and ribs. The mouth is surrounded by a circular or sub-circular lip and is suckorial. Six or seven gill openings on each side. The vertical fins are rayed.

There are two families of Cyclostomata, both of which are represented in British waters :—

The Lampreys (*Petromyzontidæ*) and

The Hags or Hag-fishes (*Myxinidæ*).

THE LAMPREYS (*Petromyzontidæ*).

In the Lampreys the body is eel-shaped, without scales. A single nasal aperture on the top of the head terminates in a

blind sac. Lampreys undergo a metamorphosis in development. The young is blind and toothless. The adult has eyes, and maxillary, mandibular, lingual and suctorial teeth are present. There are seven branchial openings on each side of the neck. Two species are found in British waters—the Sea Lamprey and the Lampern or Fresh-water Lamprey.

The Sea Lamprey (*Petromyzon marinus*).

The Sea Lamprey (Plate 136) is by far the larger of the two British Lampreys, exceeding a length of 3 feet. It may be most easily distinguished by its teeth. There are two maxillary teeth placed close together (a single one only in the Lampern); the mandibular tooth forms a crescent-shaped ridge with from seven to nine cusps; on the tongue there are four angular ridged teeth placed in pairs (only one lingual tooth in the Lampern). There are from seven to nine rows of sharp teeth on the inner side of the sucking disc, those nearest the mouth being the largest, some having two cusps. The colour of the body is well indicated in the illustration.

The Sea Lamprey is essentially a North Atlantic fish ranging from Iceland, the Faroes and Norway, to the north-west coast of Africa and the Mediterranean. It is also found on the American side as far south as Chesapeake Bay. In Great Britain and Ireland it is much more common on the west coast; on the east coast of England it is rare north of the Thames. In the spring months of the year the Sea Lamprey enters our rivers for spawning purposes. By means of their suctorial mouths they are able to attach themselves to other fish or boats. Numbers of them are frequently seen attached to the Basking Shark. When they enter the rivers they are able by the same means to attach themselves to stones and so to avoid being swept out to sea again. From this peculiarity they are sometimes called Stone-suckers.

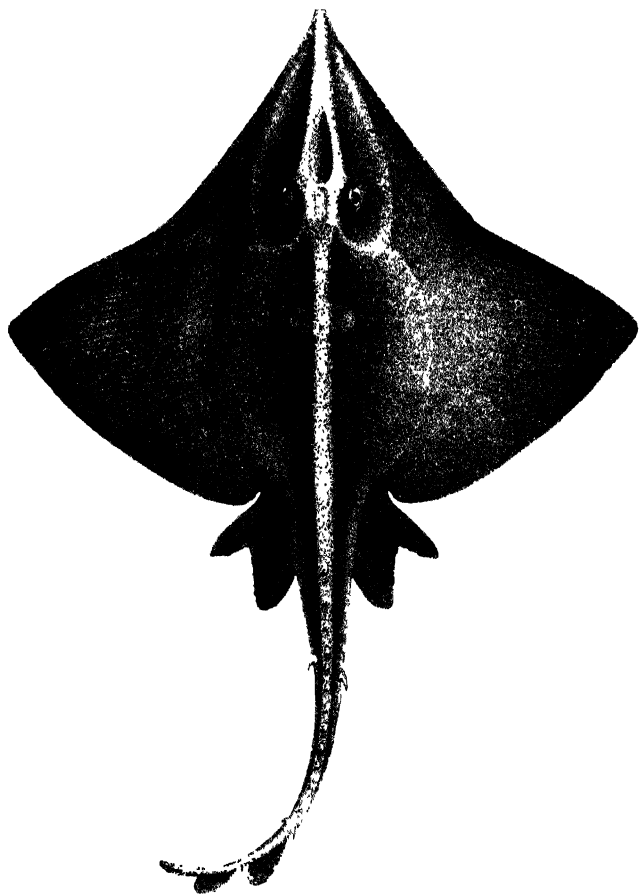
When the Sea Lamprey arrives at the mouths of our rivers, it leads a sedentary life by day, becoming active only at night. As a rule, the lampreys do not migrate far upstream. The males arrive first at the spawning grounds and begin to prepare the "nest," which is a groove in the bed of the river surrounded by stones. When the females arrive they help in the construction of the nest, and if a stone is too heavy to be moved by one fish the male and female will unite in their efforts to move it. The fish pair off together, and fertilisation of the eggs takes place immediately after they are deposited by the female. The eggs are then partly covered by the parents, who are so exhausted by the reproductive process that recovery is impossible. They drift downstream in a moribund condition, but it is possible, of course, that a few may regain the sea and ultimately recover. Spawning takes place from February to June. Soon after hatching the larva assumes a form known as *Ammocetes*, which is so different from the parent that it was at one time thought to be a distinct species, and was described under the name of *Ammocetes branchialis* (Plate 136). The *Ammocetes* is blind and toothless. It spends its larval life in the mud, and at least a year and possibly two years elapse before it migrates to the sea. This seaward migration takes place in the autumn. In the sea the Lamprey has been taken in herring nets, and it appears to migrate to considerable distances from the coast. In former times the Sea Lamprey was common enough, but at the present day it is rather a rare fish. The pollution which is now practically universal in English rivers is to a large extent responsible for this scarcity.

The Lampern (*Petromyzon* or *Lampetra fluviatilis*).

The chief difference between the Lampern (Plate 136) and the Sea Lamprey is in the appearance of the teeth, which in the Lampern consist of an outer row of small teeth, within which

in front are two rows of conical teeth with three large ones on each side. The tooth above the mouth is broad, the one below has from six to nine pointed cusps. The two dorsal fins are separate, the second being continuous with the caudal. The back is coloured dark olive-green or brown shading gradually into silver-white below. The Lampern is smaller than the Sea Lamprey, attaining a length of 16 inches only. The name Lampern is preferred here to the alternative name of River Lamprey, since it is certain that, like the Sea Lamprey, the Lampern lives for a great part of its life in the sea, coming up our rivers to spawn. This spawning migration commences at the end of September and lasts till February.

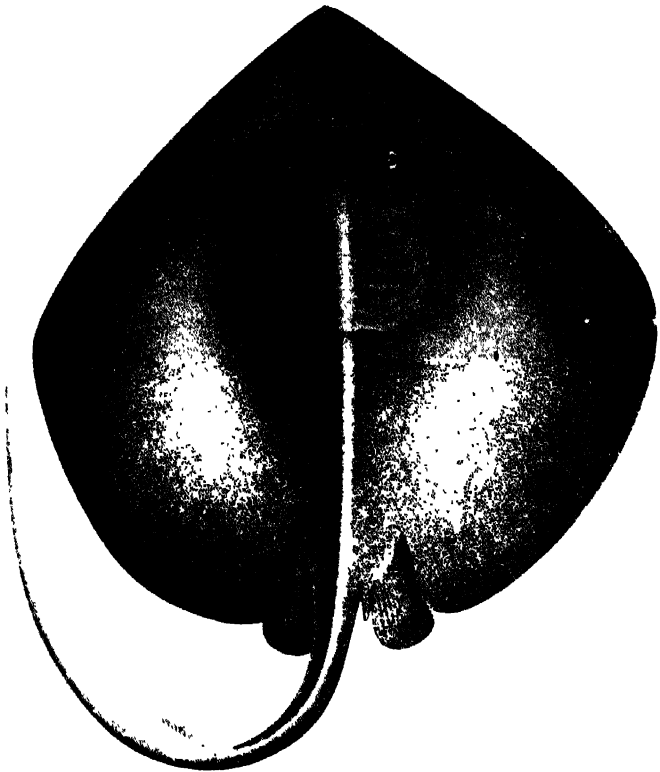
The actual spawning takes place in April and May on pebbly ground in shallow rapid-running streams. Small shoals of from 10 to 50 individuals assemble together for this purpose, and several couples work together to form a "nest," which is really a shallow groove or gutter in the pebbly or gravel bottom. In this groove the eggs are deposited. They are numerous and about 1 millimetre in diameter, and are fertilised by the male immediately after deposition. Some of the smaller lamperns appear not to migrate to sea, but to spend their lives in fresh water, moving farther up the rivers to spawn. After the spawning act is completed the Lampern, like the Sea Lamprey, is so emaciated that it probably dies. The young fish when hatched out of the eggs are worm-like and were formerly known as a distinct species, *Ammocetes branchialis* (Plate 136). The *Ammocetes* is blind and toothless. Not only is it like a worm in appearance, but it lives like a worm, embedded in mud and feeding on the organic matter found therein. This worm-like mode of life lasts from 3 to 5 years. The transformation of the *Ammocetes* into the Lampern commences in summer and ends in the autumn or winter following, when the creature has attained a length of from 6 to 8 inches, and is on its way to the sea.



Pl. 140.

Flapper Skate. (p. 340).

Z 346.



Pl. 141.

Sting Ray. (p. 341)

Z 347.

The Lampern lives on the bottom fauna and fish spawn. It also attacks other fish, boring its way into their body, where it lives a parasitic life. According to Tate Regan the Powan in Loch Lomond may frequently be seen floating on the surface of the water with lamperns attached to them, their jaws and heads buried in the flesh of the Powan. The lamperns can be carried considerable distances while attached to the flesh of their hosts; but they are also good swimmers and are capable of extensive migrations on their own account, swimming upstream against strong currents like the eel, anchoring themselves by attachment of their suctorial disc to stones. Their mode of life in the sea is unknown, as is the time they remain there. They may not remain longer than a single summer at sea. On the Continent there is a regular fishery for the Lampern, but in Great Britain and Ireland the fish is of no great economic importance. The Severn was formerly one of the main fisheries, the City of Gloucester being under an obligation to forward a dish of lampreys to the Sovereign on his accession to the throne, and annually at Christmas. King John fined the men of Gloucester 40 marks because "they did not pay him sufficient respect in the matter of his lampreys."

A third species of Lamprey, the Brook Lamprey or Pride (*Petromyzon* or *Lampetra planeri*, Plate 136), has been described. According to Tate Regan this species differs from the Lampern in that the teeth are blunter and the edge of the suctorial disc more strongly fringed. The dorsal fins are continuous, separated by a notch only; the free edge of the second disc is rounded, not angular. Other authorities regard the Brook Lamprey as merely a dwarf variety of the Lampern, which spends the whole of its life in fresh water, not descending to the sea at all. The minor differences are perhaps hardly sufficient to justify the separation of the River Lampreys or Lamperns into two species, since individuals are met with which are intermediate between the two varieties. The Brook

Lamprey is the smallest of the three species, and this supports the theory that the Sea Lamprey, Lampern and Brook Lamprey are all varieties of a single species: the first named spends most of its time at sea and grows to the largest size, the Lampern is intermediate in size and does not stay so long at sea, while the smallest, the Brook' Lamprey, does not visit the sea. It may well be that the differences in size and appearance are due to the mode of life. Brook Lampreys kept in aquaria build a tunnel in the bottom of the aquarium, which they only leave at night. They spawn the same summer. Growth is very rapid; in three months the young Brook Lampreys of 5 or 6 inches attain a length of from 8 to 10 inches. The Brook Lamprey never exceeds a length of 12 inches and is of the thickness of a lead pencil. It is not used as food, but much sought after as bait for other fish.

The Hag-fish (*Myxine glutinosa*).

In the Hag-fish the body is eel-shaped. Scales are absent. The single nasal opening is at the end of the head above the mouth, which is provided with four pairs of barbels. The mouth is devoid of lips.

The nasal opening extends back by means of a duct into the palate. The gill openings, one on each side, are a considerable distance from the head.

The Hag-fish, or "Slime-eel," Glutinous Hag or Borer, secretes thick glutinous slime in incredible quantities and with extraordinary rapidity. A single hag will fill a two-gallon bucket with slime mingled with water in a few seconds, and after only a slight interval will repeat the operation easily. The Hag also bores into the abdominal cavity of other fish, living a parasitic life on the flesh of its host.

Myxine is a fish of the North Atlantic, preferring deep water with a temperature below 50° F. It occurs in abundance off



Pl. 142.

Egg capsules of *Chimæra*. (Pl. 340).

Z 348.



P. 143.

Rabbit-fish (*Chimera*) (p. 349)

Z 349.

the Norwegian fiords in depths of 70 fathoms. In British waters it has been recorded at Newcastle and the Firth of Forth, and also from the stomach of an Angler fish on the Northumberland coast (1907). This species is hermaphrodite. The eggs are large, elliptical, provided with a horny case ; at each end there are numerous short threads for adhesion.

THE CHIMÆRIDÆ.

The living members of this family connect the cartilaginous fishes (Sharks and Rays) with the Ganoids (Sturgeon).

The body is elongated, with the mouth on the lower surface. The dental apparatus consists of two plates in the upper and one in the lower jaw. There is no spiracle. In the male there is a filament on the upper surface of the snout. The male is also provided with claspers. In adults there are no scales. There are two genera of Chimæridæ, one of which—the Rabbit-fish or King of the Herrings (*Chimæra*)—belongs to the British Fauna. There are several species of *Chimæra*, but only one—*Chimæra monstrosa*—is found in British waters.

The Rabbit-fish (*Chimæra monstrosa*).

Chimæra monstrosa (Plate 143) is a deep-water fish of the eastern North Atlantic. It has been known since the time of Pennant and Fleming as an inhabitant of the Shetland seas. From its great cutting teeth, it is known to the Shetlanders as the Rabbit-fish. From its long tapering tail it is sometimes called the Rat-fish, and because of its supposed appearance on our coasts at the same time as the Herring, it has also been named "King of the Herrings."

It is common in Iceland, but does not appear on the American side of the Atlantic. During the winter it lives at depths of 500 fathoms in the North Atlantic, wandering as far south as the South Atlantic, even to the Cape of Good Hope.

Between February, 1902, and March, 1915, there are records of 120 specimens of *Chimæra* landed by trawlers at the Aberdeen market, but of these only a few were caught within what may reasonably be called British waters. There are records 5 miles north from Rona and 5 miles west of Barra Head (Hebrides), which entitle this species to be considered as British.

Chimæra monstrosa has also been recorded off the Irish coast by Holt, 32 specimens in all, and it is not infrequently taken in Atlantic waters. Storrow obtained specimens from the Flannan Islands and the Shetlands in 1927.

It can hardly be considered a rare fish. Meek says the summer migration takes place from the deep water of the Atlantic to shallower ground on the Continental shelf for spawning purposes, and of course an inshore migration is the rule amongst fish with demersal eggs.

The egg laid by *Chimæra* is contained in a large pointed egg-case (Plate 142). The eggs have been found off the Norwegian coast, containing the fully developed embryos. In 1917 Nordgaard found the newly spawned eggs in Trondhjem fiord in April and August.

The male of *Chimæra* is provided with a peculiar erectile appendage, spiny at its extremity, situated in a groove in the top of the head. The function of this organ is unknown.

A second species (*Chimæra mirabilis*, Collett) has been recorded off the west and south-west of Ireland, but never in less depth than 250 fathoms, its principal habitat being below 500 fathoms. There are 24 records of capture of the species in the Irish Fishery Investigations Reports at a mean depth of 610 fathoms.

The male of *Chimæra* is smaller than the female, in length by about one-twelfth and in weight by about one-seventh. The food consists chiefly of crustacea and molluscs. The American species is frequently taken by hook and line, the bait being either mussels, clams, prawns, sandworms or salt pork.

APPENDIX

SINCE the publication of the first edition of this book a number of additions have been made to the list of British Fishes. The British Isles are washed by the Gulf Stream or Florida current so it is inevitable that from time to time strange fish will be caught in our bays or washed up on our coasts. Fishes normally found in the Mediterranean and adjacent parts of the Atlantic (*e.g.* Madeira, coast of Portugal) often stray to our southern coasts in the summer months.

Still more is it to be expected that new forms will be caught by our trawlers, particularly off our western coasts. Some of these trawl-caught fish have only been recorded beyond the 100 fathom line, which in the first edition was taken (p. 30) as the depth limit for British species. But many zoologists include fish as British, which, though purely deep-sea, have been caught reasonably near our shores.

In this Appendix, therefore, reference is made to all species which even on an extreme view can be regarded as British.

In most cases a brief description or reference only is given, since most of the deep-sea forms are of interest more particularly to the specialist. It seems advisable to include all British fish, whatever their habitat, so that the reader has a complete list. All British fish, therefore, not mentioned in the first edition, are referred to here. For our knowledge of the fishes of the Atlantic slope we are much indebted to the Irish researches made on the " Helga " and to the publications of Holt, Byrne and Farran ; where further details may be obtained.

To facilitate reference the page in which each family (or nearest representative) is described in the main portion of this book is given in the Appendix.

Order BERYCOMORPHI

BERYCIDAE (p. 32)

The fishes formerly grouped under the Percidae are now considered to belong to several distinct families, and the Berycidae, using the word in a broad sense, now includes several families, *e.g.* Berycidae, Diretmidae, Melamphaidae, etc. The order of Berycomorphi includes fishes which are perch-like, with a large number of rays in the ventral fins, which are thoracic. Two nostrils on each side of the head. Ventral fins with one spine and 6 to 13 soft rays.

BERYCIDAE (sensu strictu)

Beryx splendens, Lowe.

Beryx decadactylus, Cuvier and Valenciennes.

Both these species are by no means uncommon in deep water on the Irish Atlantic Slope, and are seen in our fish

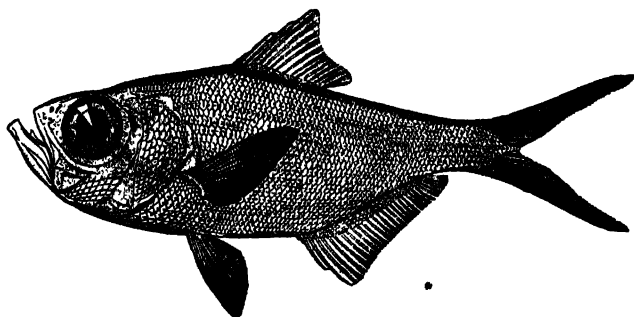


FIG. 1.—*Beryx splendens*.

markets, especially in summer. They are usually mistaken for sea bream, but may be readily distinguished by the much shorter dorsal fin and the larger eye.

DIRETMIDAE

Body much compressed, short and elevated, covered with small spinous scales, on which no lateral line can be traced, abdomen prominent, keeled.

Diretmus argenteus, Johnson. Off S.W. coast of Ireland.

TRACHICHTHYIDAE

Body ovate, deep, much compressed, with small ctenoid scales. Head large with conspicuous muciferous cavities. Suborbitals very broad covering the cheeks.

Hoplostethus mediterraneus, Cuvier and Valenciennes. Common on the Irish Atlantic Slope below 200 fathoms. (Fraser-Brunner.)

Hoplostethus atlanticus, Collett.

These two species are occasionally captured by our deep-sea trawlers and are seen in our markets.

MELAMPHAIDAE

True oceanic fishes, very rare in British waters.

Melamphaes megalops, Lütken. Head large, thick; superficial bones modified by the presence of large mucous cavities. Cleft of mouth moderate, oblique. Teeth small, villiform. More than 20 scales in longitudinal series. W. of Ireland. 84-723 fathoms.

Melamphaes beanii, Günther. Similar to the above but with less than 20 scales in longitudinal series. W. of Ireland; 1280 metres.

Order PERCOMORPHI

PERCIDAE (p. 32)

This family has now been split up.

CHILODIPTERIDAE

Epigonus telescopus, Risso. A deep-sea Atlantic and Mediterranean species. Body elongate. Eyes large, luminous. Dark violet colouration. 80 to 200 fathoms, 20 miles off Achill Head, Co. Mayo. One specimen in the trawl, Irish Atlantic Slope. Fraser-Brunner. 1934.

Order SCLEROPAREI

SCORPAENIDAE (p. 43)

Sebastes viviparus, Kröyer. Similar to *S. marinus* except that it is smaller, has a higher body, longer head, a narrower interorbital space, longer pectoral and ventral fins, and an additional soft ray in dorsal and anal.

Scorpaena cristulata, Goode and Bean. General colour bright red. Blackish or brownish blotches on gillcover. Dermal processes in the form of short slender filaments behind each of the cephalic spines and at each of the pores of the lateral line. 245 to 800 fathoms. S.W. Ireland.

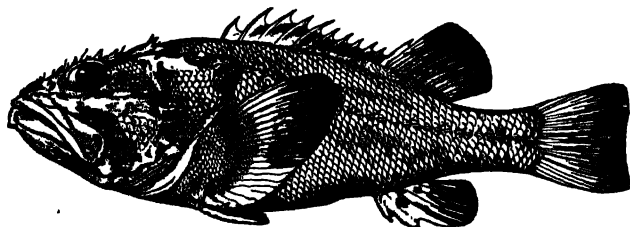


FIG. 2.—*Scorpaena cristulata*.

Scorpaena scrofa. L. Pre-eminently a Mediterranean species. Reported off Portland, August and November, 1926. (Fraser-Brunner.)

Helicolenus microphthalmus, Norman. A new species of British Scorpaenidae from the coast of Yorkshire (1935). closely related to *H. (Scorpaena) dactylopterus*.

Helicolenus dactylopterus (Delaroche). Generally occurs in deep water off the Irish Atlantic Slope (100–400 fathoms). One specimen in the British Museum from the Humber (5 fathoms).

COTTIDAE (p. 45)

Cottunculus thomsoni, Günther. Described in the "Challenger" Reports. 550 to 672 fathoms, W. of Ireland.

Order PEDICULATI (p. 57)

LOPHIIDAE

Dibranchius atlanticus. Landed by a steam trawler at Milford Haven. Taken in 240-260 fathoms lat. $49^{\circ} 40'$; long. $11^{\circ} 35'$. Sent to the National Museum of Wales, Cardiff, in January, 1934 (Matheson).

ONEIRODIDAE

Dolopichthys megaceros, Holt and Byrne. (*Oneirodes megaceros*, Holt and Byrne). A deep-sea Angler with a smooth black skin. Mouth moderate, cleft vertical. Bait in the form of a luminous bulb. Three new species described by Fraser-Brunner from the Irish Atlantic Slope, 1935, viz.: *Dolopichthys inimicus*; *Dolopichthys hibernicus* and *Gigantactis filibulbosus*.

Order PERCOMORPHI

GEMPYLIDAE (to follow Scombridae, p. 61)

Ruvettus pretiosus, Cocco. This is the El Escolar of the Spanish fishermen and has recently been added to the British fauna by Tattersall (1934). *Ruvettus* has a mackerel appear-

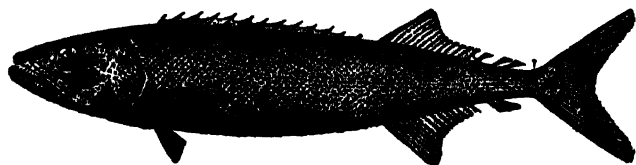


FIG. 3.—*Ruvettus pretiosus*.

ance with an elongate, fusiform, somewhat compressed body. A deep-water form, 200 to 700 fathoms.

Since *Ruvettus* yields an oil of strongly purgative properties it is known as the "Castor Oil" fish.

Nesiarchus nasutus, Johnson. Body very elongate compressed. Spinous dorsal long, pectorals comparatively low;

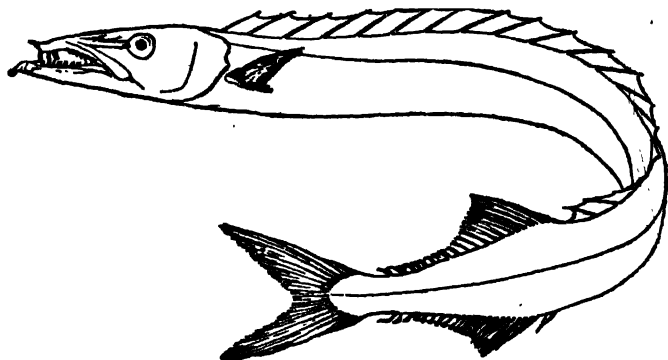


FIG. 4.—*Nesiarchus nasutus*.

caudal not keeled. Finlets absent. Scales minute. Dorsal in two portions. Dagger-shaped spine behind vent. Very rare.

Order ZEOMORPHI

ZEIDAE (p. 82)

Cyttosoma helgae, Holt and Byrne. Very rare. This species resembles the John Dory. Form compressed and elevated, more or less rhomboidal. Body and head covered with small ctenoid scales. W. of Ireland. 51° North; $11^{\circ} 57'$ West. 540–660 fathoms.

Order PERCOMORPHI

ISTIOPHORIDAE (p. 84)

Istiophorus americanus. (Cuvier and Valenciennes.) About 9 a.m. on the 17th August, 1928, a large sail-fish was captured in a moribund condition, on the flood tide in the main channel of the Yealm estuary, South Devon, opposite the Yealm Hotel,

about a mile above the Yealm Bar. It was sent to the Natural History Museum at South Kensington and identified by Norman as *Istiophorus americanus*, commonly known as the Sail-fish. The common name applied to this fish refers to its most distinctive and striking feature. The upper jaw is pro-

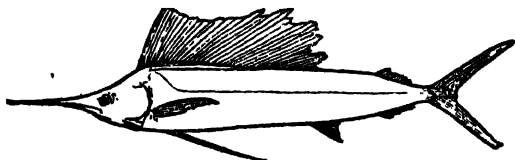


FIG. 5.—*Istiophorus americanus*.

longed into a sword-like process and the dorsal fin is large, and when expanded, sail-like. The total length of the specimen described by Norman was 2260 millimetres (about 7 feet 6 inches). A plaster cast was made from this fish.

CLINIDAE (to follow *Blennidae*, p. 108)

Parviclinus spinosus, Brunner. Fraser-Brunner has recently described (1932) a new genus, *Parviclinus*, from a specimen taken from the gullet of a marine stickleback on the Welsh coast.

ANARHICHADIDAE (p. 109)

Anarhichas latifrons, Steens. and Hallgr. A specimen was taken on the 11th April, 1928; 50 miles east of the Out Skerries (Shetlands). *A. lupus* has dark cross-bands on body. *A. minor* has many large round, black spots. *A. latifrons* is a brown form, obscurely spotted with darker patches.

Order ANACANTHINI

GADIDAE (p. 131)

Laemonema latifrons, Holt and Byrne. Closely resembles *Phycis* (the Forkbeard or Forked Hake). Has only 5 to 6 rays in first dorsal fin. Barbel small. Colour uniform

dark-brown. Taken by the "Helga" in 51° north, $11^{\circ} 55'$ west; 720 fathoms.

Mora mediterranea, Risso. Very rare. Body moderately long, eyes large. A separate caudal. Ventral composed of 6 rays. 500 fathoms. 50 miles from Achill Head, County Mayo.

Lepidion eques, Günther. Eyes large. First dorsal ray long. 500 fathoms; 54 miles off Achill Head.

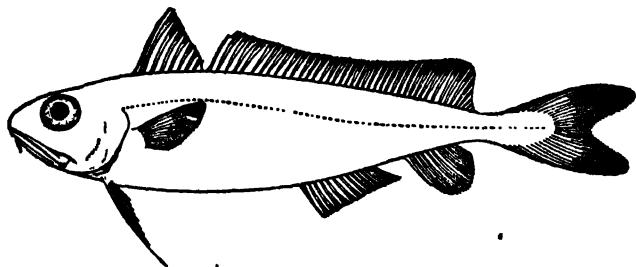


FIG. 6.—*Mora mediterranea*.

Antimora viola, Goode and Bean. Deep violet or blue in colour.

Urophycis chuss (Walbaum). Two small specimens referable to this species were recorded by Fraser-Brunner as taken in a tow-net in lat. $53^{\circ} 40'$ north, long. $11^{\circ} 15'$ west over a depth of 140 fathoms.

Halargyreus affinis, Collett. Body elongate, covered with small scales. 2 dorsal and 2 anal fins, the latter subcontinuous; ventrals with several rays. No barbel.

MACRURIDAE (CORYPHAENOIDIDAE) (to follow
Gadidae, p. 165)

Body terminates in a long compressed tapering tail, covered with spined, keeled or striated scales. Anterior dorsal fin short, posterior dorsal very long, continued to the end of the tail. Ventrals thoracic or jugular, composed of several rays. This

family consists of abyssal fish with large eyes. The head is large, mouth protrusible. A barbel present except in *Lyconus*. Bones thin. These fish are of little or no commercial value, since they rarely attain a large size. They are the most abundant family of deep-water fish off the west coast of Ireland.

Coryphaenoides rupprestris, Gunner. 509 to 775 fathoms, off County Mayo.

Coryphaenoides murrayi, Günther. 670-770 fathoms; S.W. of Ireland. This species differs from the preceding in the length of the first ray of the ventral fin. In *C. murrayi* this ray is prolonged into a filament which reaches to about the 17th anal ray.

Coelorhynchus coelorhynchus (Risso). In this genus the mouth is entirely at the lower side of the head, the first dorsal spine is smooth, whereas in *Coryphaenoides* it is finely barbed. 214 to 627 fathoms; W. and S.W. of Ireland.

Coelorhynchus labiatus (Koehler). 468 to 893 fathoms; W. and S.W. of Ireland. Colour grey, first dorsal and ventral fins black. Head ridges well marked, the most prominent is the infra-orbital.

Lionurus differs from the preceding forms in that the scales are smooth (Goode and Bean) though Farran says the "exposed portion being completely covered with small broad, flattened lancet-shaped, imbricating spinules, which project beyond the posterior margin of the scale."

Lionurus aequalis (Günther). This is the commonest Macrurid off the Irish coast; 500 fathoms; off Achill Head.

Lionurus guentheri (Vaillant). 673 to 893 fathoms, S.W. of Ireland. May be distinguished from *L. aequalis* by its longer and broader head, the inter-orbital space being equal to the vertical diameter of the eye, and the snout equal to its horizontal diameter.

Malacocephalus laevis (Lowe). 187 to 534 fathoms, S.W. of Ireland. This species is figured in Goode and Bean "Oceanic Ichthyology" Fig. 346, but under the name of *Nematonurus gigas*.

In *Malacocephalus* the ventrals are short and weak, pectoral situated very high, opposite upper angle of gill-cleft. Dorsal spine smooth, scales small, bristly.

Bathygadus melanobranchus (Vaillant). 549 to 646 fathoms,

S.W. of Ireland. Colour silvery, lining of mouth and gill-cavity deep brownish-black. In this species the snout is short and blunt; jaws even in front. Teeth in jaws in villiform bands. Bones of head soft and cavernous.

Trachyrhynchus has a long pointed snout. Teeth in villiform bands in the jaws. A row of armed scales at the base of the vertical fins anteriorly. Operculum very small, barbel present.

Trachyrhynchus trachyrhynchus (Risso), p. 30. This species, which is occasionally captured by steam trawlers, frequents the W. and S.W. of Ireland in depths from 300 to 600 fathoms.

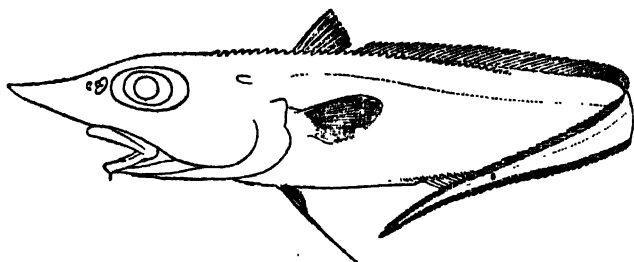


FIG. 7.—*Trachyrhynchus trachyrhynchus*.

Trachyrhynchus murrayi, Günther. 698–720 fathoms W. and S.W. of Ireland.

Lyconus brachycolus, Holt and Byrne. S.W. of Ireland. It is doubtful whether this is a deep-water or mid-water form. The body terminates in a long compressed tapering tail, covered with small scales. A dorsal fin continues to the end of the tail. Anal fin long, extends from vent to end of tail. No caudal. Ventrals thoracic.

Nematonurus farrani, Fraser-Brunner. A new species of the Coryphaenoididae has recently been described by Fraser-Brunner (1935) from five specimens taken in two hauls of the trawl in 210 to 290 fathoms, on the fishing ground known as the "Farm" on the Irish Slope in lat. $52^{\circ} 35'$ north, long. $13^{\circ} 3'$ west.

Order PERCOMORPHI

AMMODYTIDAE (p. 165)

Ammodytes cicerellus, Rafinesque. This species has recently been recorded from the Shetland Islands from depths of 80 to 90 fathoms. In 1928 over 1600 specimens were trawled by the Scottish Fishery Research steamer "Explorer" on the east side of St. Kilda. It differs from the other species of *Ammodytes* in that the outer margins of the dorsal and anal fins are wavy, in *A. lanceolatus* and *A. tobianus* the outer margins of these two fins are straight. A fourth British species, *A. marinus* has recently been noted by Raitt (1934).

Ammodytes marinus, Raitt. A fourth species of *Ammodytes* is reported by Raitt, who says it occurs in even greater numbers than the three known forms in the North Sea and N.E. Atlantic. It closely resembles *A. tobianus* but differs in fin ray and vertebral numbers. The number of vertebrae in *A. tobianus* is given as 62 to 65, in *A. marinus* from 67 to 72. A total of 3357 adult specimens of *A. marinus* has been collected in the last six years; off the E. coast of Scotland, the Orkneys, Shetlands and Outer Hebrides.

Order HETEROSOMATA

BOTHIDAE (p. 202)

Arnoglossus imperialis (Rafinesque). This species is very like the common Scald-fish (p. 203) the chief difference being that in *A. imperialis* the anterior rays of the dorsal fin are more or less prolonged. Recorded from Falmouth Bay, Plymouth and "off Cardiff."

Lepidorhombus boscii (Risso). Is much like the Megrim (p. 202), but has from 87 to 93 scales in the lateral line instead of the 95 to 109 of the Megrim. A deep-water species recorded off S.W. Ireland (150 fathoms); also 140 fathoms off County Kerry; 180 fathoms off Fastnet, Co. Cork. Not uncommon off the W. and S.W. coasts of Ireland. Range from 106-400 fathoms. Largest hauls 150 to 350 fathoms.

PLEURONECTIDAE

Reinhardtius hippoglossoides (Walbaum). The Greenland or Lesser Halibut, a fish of increasing economic importance, resembles the halibut (p. 190), but its upper eye has a vertical range, compared with the upper eye of the halibut proper which is lateral in position. In the Greenland Halibut the inter-orbital space is broader than the orbit (narrower in the Halibut). Norman has described a specimen taken by a steam trawler in 52° 30' north; S.W. of Ireland in 170 fathoms. It was 720 millimetres long; the first British record (1924).

SOLEIDAE

Dicologlossia azevia (Capello). Doubtfully British. The same species as *Solea azevia* (p. 194).

Bathysolea profundicola (Vaillant). Very rare. Same species as *Solea profundicola* (p. 194).

Order SOLENICHTHYES

SYNGNATHIDAE (p. 208)

Syngnathus rostellatus, Nilsson. Occurs quite frequently in British waters, and has been taken in the Thames estuary.

Order INIOMI

SCOPELIDAE (p. 214)

This family is now split up and we may consider British species under the following two families :—

SUDIDAE (p. 215). In addition to *Paralepis coregonides*

Bathypterois dubius, Vaillant. The most marked characteristic is that the upper pectoral ray is entirely detached, thickened and developed as a tactile organ, extensible upwards. Ventrals abdominal with the outer rays prolonged. Eye very small. Dorsal fin inserted in the middle of the body above, or just behind the root of the ventral, moderately long.

Anal short. Caudal forked. Gill openings very wide. Off the Tearaght Light, Kerry. 673-893 fathoms.

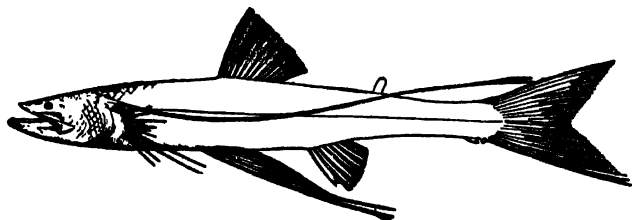


FIG. 8.—*Bathypterois dubius*.

Paralepis coregonides, Risso. Head and body elongate, compressed. Dorsal fin short, on hind part of body. Eye large. Pectorals well developed. Ventrals small, inserted at a great distance from the pectorals, just behind the dorsal fin.

MYCTOPHIDAE (p. 215)

Small pelagic fish with large eyes and wide mouth. No barbels, lateral line present, the scales prominent and often enlarged. Adipose fin present. Caudal forked. Sides scaly, with phosphorescent spots (photophores).

This family includes eleven species which are claimed as British. These eleven species are comprised in the four genera *Myctophum* (four species), *Diaphus* (three species), *Lampanyctus* (three species) and *Lampadena* (one species). *Myctophum* includes many species formerly included in *Scopelus*.

An important means of identification is provided by the photophores (luminous organs), which seem to be constant in form and arrangement in each species.

The four species (British) of *Myctophum* are :—

Myctophum glaciale (Reinhardt). Widely distributed, Irish Atlantic Slope, usually beyond 400 fathoms, a fish of wide range.

Myctophum arcticum (Lutken). 630 fathoms, W. of Ireland. Attains a length of about 1½ inches. Photophores bright and adherent.

Myctophum humboldti (Risso). Off the Tearaght Light, Kerry. Taken at the surface after dark. Attains a length of $4\frac{1}{2}$ inches.

Myctophum punctatum (Rafin.). Same locality. Also west of Shetland and off the mouth of the English Channel. Not uncommon.

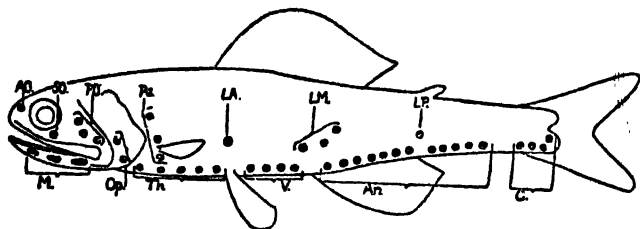


FIG. 9.—*Diagram of Scopelus.*
(Showing arrangement of Photophores)

AO. Antorbital; SO. Suborbital; PO. Postorbital organs which vary in number and in size in different species.

M. mandibular series, always present and always 3 in number.

Op. Opercular series, always present and usually 2 or 3 in number.

Longitudinal ventral series:

Th. Thoracic; V. Ventral; An. Anal, often broken into an anterior and posterior series.

C. Caudal, sometimes continuous with the Anals.

On the sides above the ventral series:

Pe. three in number varying in position in different species.

LA. Anterolateral; L.M. Mediolateral, 3 in number whose arrangement is very important in telling different species apart.

L.P. Posterolateral, not always present and varying in number.

The three species of *Diaphus* are:—

Diaphus dumerili (Bleeker). S. W. Ireland; Fraser-Brunner, 1934.

Diaphus rafinesquei (Cocco).

Diaphus dofleini (Zugmayer). Off the Lizard; F.-B., 1934.

The three species of *Lampanyctus* are:—

Lampanyctus elongatus (Costa). Off the Lizard; F.-B., 1934.

Lampanyctus crocodilus (Risso).

Lampanyctus gemmifer, Goode and Bean. S. W. Ireland; F.-B., 1934.

The species of *Lampadena* is :—

Lampadena chavesi, Collett.

ALEPISAUROIDÆ (to follow *Scopelidae*, p. 215)

Alepisaurus ferox, Lowe. Gregory Absalom records this species taken off St. Kilda in 1911, the first British record. *Alepisaurus* is a deep-sea fish, common off Madeira, where it is obtained by the fishermen on their lines. It may be regarded

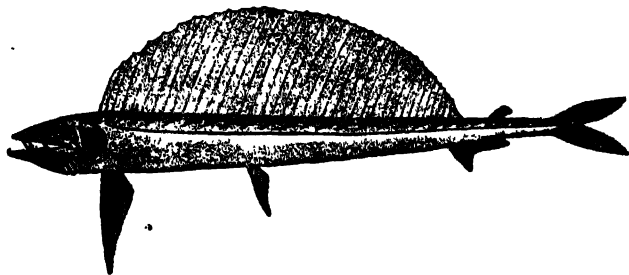


FIG. 10.—*Alepisaurus ferox*.

as a denizen of the Western Atlantic and individuals undoubtedly approach our coasts from time to time. The fish is long and narrow, its most remarkable feature being the large dorsal fin which is much elevated and may be considered to represent a sail. Behind this large dorsal there is a small adipose fin.

Order ISOSPONDYLI

ARGENTINIDÆ (p. 248)

Bathylagus atlanticus, Günther. Three species of *Bathylagus* are found in deep-water in the Atlantic slope off the W. and S.W. of Ireland. *Bathylagus atlanticus* is a deep-water form with body oblong, compressed. Scales of moderate size. An adipose fin. No luminous organs. Colour black. 1000 to 1500 fathoms; off County Mayo.

Bathylagus glacialis, Regan.

Bathylagus euryops, Goode and Bean. Taken off the Irish coast in open nets fished at depths of 400 to 900 fathoms. As most of the captures were made in mid-water nets, it is probably



FIG. 11.—*Bathylagus euryops*.

of pelagic habit. Attains a length of $6\frac{1}{4}$ inches (without caudal fin).

ALEPOCEPHALIDAE (to precede *Clupeidae*, p. 255)

This family consists of deep-sea forms, near to the *Clupeidae* and *Salmonidae*, but with no dorsal adipose fin. The rayed fin is far back on the body. Head scaleless. Eyes usually large. Both dorsal and anal fins low. Pectoral and ventral fins small, the latter sometimes wanting; when present set far back. Five species have been recorded on the Irish Atlantic Slope.

Alepocephalus rostratus, Cuvier and Valenciennes. Back with a distinct narrow ridge running forward from dorsal fin

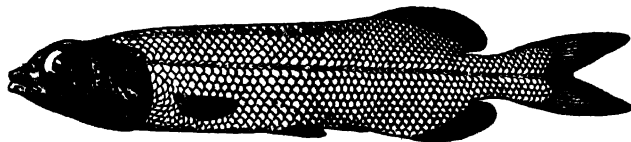


FIG. 12.—*Alepocephalus rostratus*.

to region of shoulder. Colour uniform black, head deep velvety black, body purplish black. The body is covered with large scales. 500 to 600 fathoms; off Tearaght Light, Ireland.

Alepocephalus giardi, Koehler. Similar to the above but distinguished by the absence of the dorsal ridge and con-

sequent less height of the body, by the longer caudal peduncle and the greater number of scales. 50 to 70 fathoms; off Tearaght Light. Also off Achill Head.

Alepocephalus macropterus, Vaillant. Similar to the preceding, but scales very small. 194 to 222 transverse rows between head and origin of central caudal rays. 673 to 893 fathoms; W. of Ireland.

Bathytroctes rostratus, Günther. Similar to *Alepocephalus* but has teeth on the maxilla and the dorsal fin equal to or longer than the anal. Head and abdominal region black, rest of body brownish-grey. 650 to 1100 fathoms; W. of Ireland.

Xenodermichthys socialis, Vaillant. Body elongate, more or less compressed. Snout obtuse. Eyes large. Numerous small photophores (luminous organs), generally distributed. 230 to 500 fathoms; W. of Ireland.

GONOSTOMATIDAE (to follow *Clupeidae*, p. 266)

Generally small, deep-sea fishes, though some reach a length of 15 inches or more.

Gonostoma bathyphilium (Vaillant). Body elongate, dorsals behind ventrals. No scales. Photophores small. Vertical fins moderate in length. Four records from the Irish Atlantic Slope ("Helga").



FIG. 13.—*Gonostoma bathyphilium*.

Cyclothone microdon. (Günther). Differs from the preceding in the form of the teeth, smaller eye and fewer rays in the anal fin. Although many hundreds of specimens are in the National Museum, U.S.A., the species is so delicate and hard to preserve that not one gives satisfactory opportunity for study. Numerous specimens from the Irish Atlantic Slope ("Helga").

Yarrella blackfordi (Goode and Bean). Differs from the above in the position of the dorsal fin which is further forward, its origin in advance of the anal. An adipose fin. Off the Lizard; F.-B., 1934.

Valenciennellus tripunctulatus (Esmark). Luminous spots arranged in and placed on black bodies. Off the Lizard; F.-B., 1934.

Maurolicus muelleri (Gmelin). This is the same species mentioned on p. 214 as *Scopelus* or *Maurolicus pennanti*. A shoaling fish. On the Irish Atlantic Slope its range extends to within the 100 fathom line. Caught in nets fastened to trawls and in the trawl itself, also in mid-water trawl. Young and half-grown examples abundant at the surface.

STERNOPTYCHIDAE (to follow p. 266)

Small deep-sea and pelagic fish of peculiar shape, the trunk being much elevated and compressed. Body covered with a silvery pigment, without scales; photophores along the lower side of the head, body and tail.

Argyrolepecus hemigymnus, Cocco. This species is referred

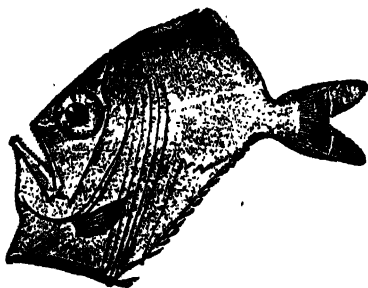


FIG. 14.—*Sternoptyx diaphana*.

to on p. 215. The fore part of the body is high and laterally compressed. A single serrated abdominal spine. Numerous records, Irish Atlantic Slope ("Helga"). 200 to 900 fathoms.

Argyropelecus olfersi (Cuvier). Greatest depth of body two-thirds of length; it is $\frac{1}{2}$ in. hemigymnus. A pair of smooth abdominal spines. Four Irish records ("Helga"). 380 to 690 fathoms. These fish are true oceanic forms pelagic in habit and normally living in the upper layers of the sea. Off the Lizard; F.-B., 1934.

Sternoptyx diaphana, Hermann. Greatest depth of body slightly less than total length. One record by the "Helga" from the Irish Atlantic Slope. 600-990 fathoms.

Polyipnus spinosus, Günther. Differs from *Sternoptyx* in having the body covered with very large anterior scales. Lacks anterior spinal dilatation of the anal fin.

ASTRONESTHIDAE (to follow p. 266)

Deep-sea fish with long barbel and formidable dentition. Generally two dorsal fins of which the posterior is adipose.

ASTRONESTHIDAE

Stomatoid fishes with adipose dorsal present, and scaleless body. Dorsal fin inserted behind vent, but in front of anal.

Astronesthes niger, Richardson. Colour black, with 22 luminous spots between chin and ventrals. Barbel longer than head. Dorsal begins just behind base of ventrals.

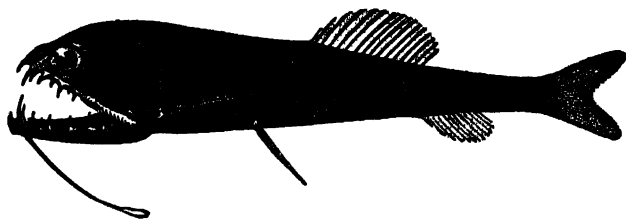


FIG. 15.—*Astronesthes niger*.

Diplolynchus bifilis, Regan and Trewavas. Barbel a little more than half the length of head with two filaments near the end. Dorsal originating above or immediately behind base of

pelvics. A specimen 65 millimetres in length to base of caudal. From the Atlantic $46^{\circ} 28'$ north $8^{\circ} 01'$ west. Two specimens in the British Museum (Natural History) 43 and 45 millimetres long, from off Ireland.

STOMIATIDAE (to follow p. 266)

Fishes with elongate body, tapering and covered with scales, which are deciduous. Teeth strong, often fang-like or barbed.

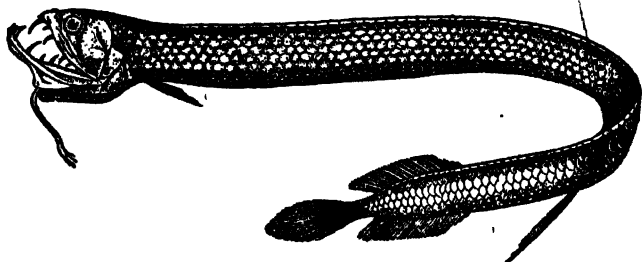


FIG. 16.—*Stomias boa*.

A barbel. Dorsal short, posterior. Mouth enormous with deep lateral cleft.

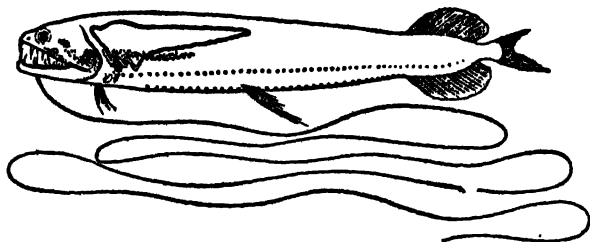


FIG. 17.—*Lamprotozus flagellibarba*.

Stomias boa (Risso). A pelagic fish, ranging from the N.W. of the Hebrides to the Cape of Good Hope, only found

outside the 500 fathom line. Taken at night at the actual surface by the Irish research steamer "Helga." Is a normal, if not very common denizen of the region explored by the "Helga." Numerous records, tounet and trawl, surface to 700 fathoms. Also 95 miles S.W. by W. of the Fastnet (O'Connor).

Lamprotoxus flagellibarba (Holt and Byrne). Colour velvet black. Very long barbel. A cord-like band of luminous tissue forms loop on anterior part of body. Taken by the "Helga" at 51° 20' north and 11° 56' west. The only record.

Order APODES

SERRIVOMERIDAE (to follow p. 267)

Serrivomer beani, Gill and Ryder. Body very slender, somewhat compressed, tapering to a long and slender tail. No scales. Neck long and slender. Head resembles the Garfish (*Belone*). Teeth in both jaws small, very numerous, close set, retrorse. W. of Ireland.

NEMICHTHYIDAE (p. 267)

Nemichthys scolopaceus, Richardson. Very rare. Recorded on the Irish Atlantic Slope.

Avocettina infans, Günther. These are small deep-sea eels resembling *Serrivomer*, but with the jaws much longer and more

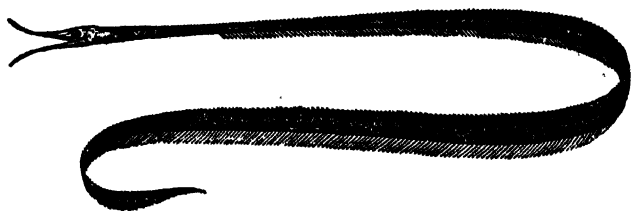


FIG. 18.—*Avocettina infans*.

slender. Tail ending in a long filament. Colour dusky with silvery reflections above.

A specimen of *Avocettina infans* was picked up on the shore at Borth, Cardigan Bay, on the 10th October, 1926, after a westerly gale. It measured $16\frac{1}{2}$ inches in length and its stomach contained foraminifera.

SYNAPHOBRANCHIDAE (p. 276)

Nettophichthys retropinnatus, Holt. In addition to the *Synaphobranchus* another species of this family has been recorded by Holt from the west coast of Ireland, at a depth of 144 fathoms.

Order HETEROMI

NOTACANTHIDAE (to follow *Synaphobranchus*, p. 276)

The Notacanthidae are deep-sea fish with an elongate body. Very small cycloid scales. Mouth small, inferior. Dorsal fin formed by a series of short disconnected spines. Anal very long, partly of spines, partly of soft rays.

Notacanthus bonaparti, Risso. Origin of dorsal considerably in advance of that of anal. Lip normal, continuous.

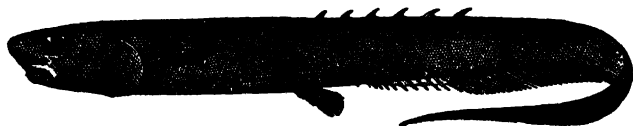


FIG. 19.—*Notacanthus bonaparti*.

Lateral line inconspicuous, nearer to dorsal than ventral throughout, not arched anteriorly. 337 to 411 fathoms, off the Tearaght, County Kerry.

Macdonaldia rostrata, Collett. Differs from the preceding species in having 27 to 38 dorsal spines. Ventral fins separate. 533 to 778 fathoms, W. and S.W. of Ireland.

Order PLEUROTREMATA

SCYLIORHINIDAE (pp. 306 and 317)

Pristiurus murinus, Collett (p. 319). This species resembles the Black-mouthed Dogfish (*P. melanostomus*), except that its body is uniformly coloured. It has been recorded from the N.W. of the Hebrides in depths from 600 to 875 fathoms.

SQUALIDAE SPINACIDAE (p. 319)

Oxynotus paradoxus, Frade. Although it was originally thought there was only one species of *Oxynotus*, namely the well-known Humantin (*Oxynotus centrina*, Linn), comparison of other specimens has led Norman to conclude that there is a second species, which is a new record for the British fauna.

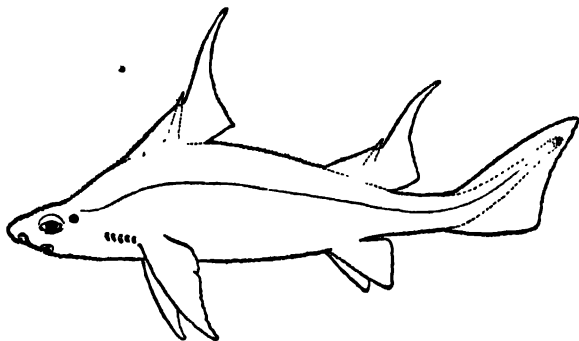


FIG. 20.—*Oxynotus paradoxus*.

This species, *Oxynotus paradoxus*, was described by Frade from the coast of Morocco. In 1931, the British Museum received two specimens of this fish, one 475 millimetres in length, 70 miles W.N.W. of the Fastnet, S.W. of Ireland; the other, 750 millimetres in length from the Black Rock Grounds off the N.W. of Ireland, at a depth of 160 fathoms. Norman, who examined these specimens, regards them as a distinct species from the

Humantin. In the Humantin the spine of the first dorsal fin projects forwards, in *Oxynotus paradoxus* backwards. The spiracle in the Humantin is oval or crescentic, in *paradoxus* circular; the denticles in *paradoxus* are larger and more widely separated than in the Humantin, giving *paradoxus* a much rougher appearance. The Humantin is brown; *paradoxus*, black.

Fraser-Brunner caught a fine male example of *O. paradoxus* in the trawl at a depth of 145 fathoms on the Irish Atlantic Slope in lat. $53^{\circ} 40'$, long. $11^{\circ} 15'$ west. All the specimens described by Norman were females. The male is essentially similar to the female in all respects except for the claspers, which are as long as the snout and quite smooth.

A Scottish specimen was taken in the middle of March, 1933, in a trawl at Scourie Bank, 5 miles south of the Isle of Handa in the Minch, by the trawler "George Hastie," and landed at Aberdeen. This specimen is now mounted and on exhibition at the Royal Scottish Museum (Stephen).

Scymnodon ringens, Bocage and Capello. • Snout long, pointed. Mouth inferior. Two dorsal fins, small, each preceded by a short spine. Upper teeth simple, pointed; lower teeth erect, triangular. Recorded from Scotland (Sim, 1902).

CHLAMYDOSELACHIDAE

Chlamydoselachus anguineus, Garman. The Frilled Shark. A specimen of this very rare species was taken off the west coast of Ireland in deep water (1935). A second specimen was taken in April, 1936, by the Milford trawler "Michael Griffith" in 350 fathoms, off the W. of Ireland and sent to the National Museum of Wales. It occurs in Japan and in the eastern Atlantic and (until these specimens were captured) nowhere else.

Order HYPOTREMATA

TORPEDINIDAE (p. 328)

In addition to the *Torpedo nobiliana*, Bonaparte, mentioned on p. 329 there are two species, which are doubtfully British; *Torpedo marmorata*, Risso, and *Torpedo torpedo* (L).

RAJIDAE (p. 330)

Raja fyllae, Lutken. A medium sized, deep-water ray of high northern latitudes. In the adult there are 2 to 3 rows of strong alar spines. Has been taken between the Faroe and Shetland Islands. 216 to 983 fathoms.

Raja lintea, Fries. A north Atlantic deep-water species (80 to 350 fathoms). Recorded from the west of Ireland (Holt and Byrne). Also from the Faroe-Shetlands. Known to fishermen as the Sharp-nosed Skate.

CHIMAERIDAE (p. 349)

Rhinochimaera atlantica, Holt and Byrne. Snout prolonged as a long tapering appendage without cutaneous flap,

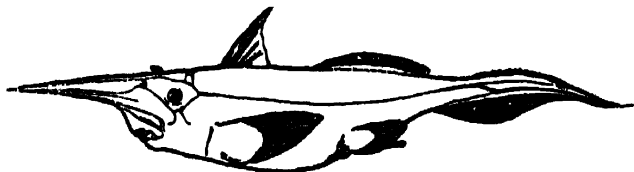


FIG. 21.—*Rhinochimaera atlantica*.

dorsal portion of caudal fin reduced to a fold of skin with a few dermal denticles on its edge. S.W. of Ireland. 670 to 770 fathoms.

LIST OF FISHES OF THE BRITISH ISLES
WITH THEIR
COMMON AND SCIENTIFIC NAMES.

Class MARSIPOBRANCHII

Order HYPEROARTIA

PETROMYZONIDAE

Sea Lamprey. *Petromyzon marinus*, Linn.

Lampern. *Lampetra fluviatilis* (Linn.) = *Petromyzon fluviatilis*,
Day.

Brook Lamprey. *Lampetra planeri* (Bloch) = *Petromyzon branchialis*, Day.

Order HYPEROTRETA

MYXINIDAE

Hag-fish. *Myxine glutinosa*, Linn.

Class SELACHII

Sub-Class EUSELACHII

Order PLEUROTREMATA

CHLAMYDOSELACHIDAE

Frilled Shark. *Chlamydoselachus anguineus*, Garman.

HEXANCHIDAE

Six-gilled Shark. *Hexanchus griseus* (Gmelin) = *Notidanus griseus*,
Day.

LAMNIDAE

Porbeagle. *Lamna cornubica* (Gmelin).

Basking Shark. *Cetorhinus maximus* (Gunner) = *Selache maxima*,
Day.

Thresher. *Alopias vulpes* (Gmelin).

SCYLIORHINIDAE

- Greater-spotted Dogfish. *Scyliorhinus stellaris* (Linn.) = *Scyllium catulus*, Day.
 Lesser-spotted Dogfish. *Scyliorhinus caniculus* (Linn.).
 Black-mouthed Dogfish. *Pristiurus melastomus*, Rafinesque.
Pristiurus murinus, Collett.

CARCHARINIDAE

- Blue Shark. *Carcharinus glaucus* (Linn.) = *Carcharias glaucus*, Day.
 Tope. *Eugaleus galeus* (Linn.) = *Galeus vulgaris*, Day.
 Smooth Hound. *Mustelus mustelus* (Linn.) = *M. vulgaris*, Day.
 Hammerhead Shark. *Sphyrna zygaena* (Linn.) = *Zygaena malleus*, Day.

SQUALIDAE

- Spinous Shark. *Echinorhinus spinosus* (Gmelin).
 Humantin. *Oxynotus centrina* (Linn.) = *Centrina salviani*, Day.
Oxynotus paradoxus, Frade.
Spinax spinax (Linn.) = *Spinax niger*, Jenkins.
 Piked Dogfish. *Squalus acanthias*, Linn. = *Acanthias vulgaris*, Day.
Scymnodon ringens, Bocage and Capello.
Centrophorus calceus (Lowe).
 " *squamosus* (Gmelin).
Scymnorhinus licha (Bonnaterre).
 Greenland Shark. *Somniosus microcephalus* (Schneider) = *Laemargus microcephalus*, Day.

SQUATINIDAE

- Monk-fish. *Squatina squatina* (Linn.) = *Rhina squatina*, Day.

Order HYPOTREMATA

TORPEDINIDAE

- Torpedo marmorata*, Risso.
 " *torpedo* (Linn.).
 Electric Ray. *Torpedo nobiliana*, Bonaparte.

RAJIDAE

- Spotted Ray. *Raja montagui*, Fowler = *R. maculata*, Day.
 Blonde Ray. *Raja brachyura*, Lafont.
 Undulate Ray. *Raja undulata*, Lacepède.
 Painted Ray. *Raja microcellata*, Montagu.
 Thornback Ray. *Raja clavata*, Linn.
 Starry Ray. *Raja radiata*, Donovan.
 Cuckoo Ray. *Raja naevus*, Müller and Henle = *R. circularis*, Day.
 Sandy Ray. *Raja circularis*, Couch.
 Shagreen Ray. *Raja fullonica*, Linn.
Raja fyllae, Lütken.
 „ *lutea*, Fries.
 White Skate. *Raja marginata*, Lacepède = *R. alba*, Day.
 Common Skate. *Raja batis*, Linn.
 Flapper Skate. *Raja macrorhynchus*, Rafinesque.
 Long-nosed Skate. *Raja oxyrhynchus*, Linn.

TRYGONIDAE

- Sting Ray. *Trygon pastinaca* (Linn.).

MYLIOBATIDAE

- Eagle Ray. *Myliobatis aquila* (Linn.).

MOBULIDAE

- Horned Ray. *Mobula giorna* (Lacepède) = *Cephalopterus giorna*, Risso.

Sub-Class HOLOCEPHALI

CHIMAERIDAE

- Rabbit-fish. *Chimaera monstrosa*, Linn.
Chimaera mirabilis, Collett.
Rhinokhimaera atlantica, Holt and Byrne.

Class PISCES

Sub-Class PALAEOPTERYGII

Order CHONDROSTEI

ACIPENSERIDAE

- Sturgeon. *Acipenser sturio*, Linn.

Sub-Class NEOPTERYGII

Order ISOSPONDYLI

ALEPOCEPHALIDAE

Alepocephalus rostratus, Cuvier and Valenciennes.„ *giardi*, Koehler.„ *macropterus*, Vaillant.*Bathytroctes rostratus*, Günther.*Xenodermichthys socialis*, Vaillant.

CLUPEIDAE

Herring. *Clupea harengus*, Linn.Sprat. *Clupea sprattus*, Linn.Allis Shad. *Alosa alosa* (Linn.) = *Clupea alosa*, Day.Twaite Shad. *Alosa finta* (Cuvier) = *Clupea finta*, Day.Pilchard. *Sardina pilchardus* (Walbaum) = *Clupea pilchardus*, Day.Anchovy. *Engraulis encrasicolus* (Linn.).

GONOSTOMATIDAE

Gonostoma bathyphilum (Vaillant).*Cyclothone microdon* (Günther).*Yarrella blackfordi*, Goode and Bean.Pearl-side. *Mauroliscus muelleri* (Gmelin) = *M. pennantii*, Day.*Valenciennellus tripunctulatus* (Esmark).

STERNOPTYCHIIDAE

Argyropelecus hemigymnus, Cocco.„ *olfersii* (Cuvier).*Sternoptyx diaphana*, Hermann.*Polyipnus spinosus*, Günther.

ASTRONESTHIDAE

Astronesthes niger, Richardson.*Diplolychnus bifilis*, Regan and Trewavas.

STOMIATIDAE

Stomias boa (Risso).*Lamprotoxus flagellibarba* (Holt and Byrne).

SALMONIDAE

- Salmon. *Salmo salar*, Linn.
 Trout. *Salmo trutta*, Linn.
 Rainbow Trout. *Salmo irideus*, Gibbons.
 Char. *Salvelinus alpinus*, Linn.
 Willoughby's Char. *Salvelinus willoughbii* (Günther).
 Lonsdale's Char. *Salvelinus lonsdalei*, Regan.
 Large-mouthed Char. *Salvelinus maxillaris*, Regan.
 Torgoch. *Salvelinus perisii* (Günther).
 Malloch's Char. *Salvelinus mallochi*, Regan.
 Haddy. *Salvelinus killinensis* (Günther).
 Orkney Char. *Salvelinus inframundus*, Regan.
 Struan Char. *Salvelinus struanensis* (Gibson-Maitland).
 Shetland Char. *Salvelinus gracillimus*, Regan.
 Cole's Char. *Salvelinus colii* (Günther).
 Gray's Char. *Salvelinus grayi* (Günther).
 Trevelyan's Char. *Salvelinus trevelyanii*, Regan.
 Coomasaham Char. *Salvelinus fimbriatus*, Regan.
 Scharff's Char. *Salvelinus scharffi*, Regan.
 Blunt-snouted Irish Char. *Salvelinus obtusus*, Regan.
 Brook Trout. *Salvelinus fontinalis* (Mitchell).
 Lochmaben Vendace. *Coregonus vandesius*, Richardson.
 Cumberland Vendace. *Coregonus vandesius gracilior*, Regan.
 Pollan. *Coregonus pollan*, Thompson.
 Lough Erne Pollan. *Coregonus pollan altior*, Regan.
 Shannon Pollan. *Coregonus pollan elegans*, Thompson.
 Powan. *Coregonus clupeioides*, Lacepède.
 Schelly. *Coregonus clupeioides stigmaticus*, Regan.
 Gwyniad. *Coregonus clupeioides pennantii*, Cuvier and Valenciennes.
 Houting. *Coregonus oxyrhynchus* (Linn.).
 Grayling. *Thymallus thymallus* (Linn.) = *T. vulgaris*, Day.

ARGENTINIDAE

- Argentine. *Argentina sphyraena*, Linn.
Argentina silus (Ascanius).
Bathylagus atlanticus, Günther.
 „ *glacialis*, Regan.
 „ *euryops*, Goode and Bean.

OSMERIDAE

- Smelt. *Osmerus eperlanus* (Linn.).

Order HAPLOMI

ESOCIDAE

Pike. *Esox lucius*, Linn.

Order INIOMI

SUDIDAE

Paralepis coregonoides, Risso.

Bathypterois dubius, Vaillant.

MYCTOPHIDAE

Myctophum glaciale (Reinhardt).

„ *articum* (Lütken).

„ *humboldti* (Risso).

„ *punctatum* (Rafinesque).

Diaphus rafinesquei (Cocco).

„ *dofleini* (Zugmayer).

„ *dumerili* (Bleeker).

Lampanyctus elongatus (Costa).

„ *crocodilus* (Risso).

„ *gemmifer*, Goode and Bean.

Lampadena chavesi, Collett.

ALEPISAUROIDAE

Alepisaurus ferox, Lowe.

Order OSTARIOPHYSI

CYPRINIDAE

Carp. *Cyprinus carpio*, Linn.

Crucian Carp. *Carassius carassius* (Linn.) = *C. vulgaris*, Day.

Goldfish. *Carassius auratus* (Linn.).

Barbel. *Barbus barbus* (Linn.) = *B. vulgaris*, Day.

Gudgeon. *Gobio gobio* (Linn.) = *G. fluviatilis*, Day.

Tench. *Tinca tinca* (Linn.) = *T. vulgaris*, Day.

Minnow. *Phoxinus phoxinus* (Linn.) = *Leuciscus phoxinus*, Day.

Chub. *Squalius cephalus* (Linn.) = *Leuciscus cephalus*, Day.

Dace. *Leuciscus leuciscus* (Linn.) = *L. vulgaris*, Day.

Roach. *Rutilus rutilus* (Linn.) = *L. rutilus*, Day.

Rudd. *Scardinius erythrophthalmus* (Linn.) = *L. erythrophthalmus*, Day.

White Bream. *Blicca bjoernka* (Linn.) = *Abramis blicca*, Day.

Bream. *Abramis brama* (Linn.).

Bleak. *Alburnus alburnus* (Linn.) = *A. lucidus*, Day.

COBITIDAE

Loach or Stone Loach. *Nemacheilus barbatula* (Linn.).
 Spined Loach. *Cobitis taenia*, Linn.

Order APODES

ANGUILLIDAE

Eel. *Anguilla anguilla* (Linn.) = *A. vulgaris*, Day.

MURAENIDAE

Muray. *Muraena helena*, Linn.

SERRIVOMERIDAE

Serrivomer beani, Gill and Ryder.

NEMICHTHYIDAE

Nemichthys scolopaceus, Richardson.
Avocettina infans (Günther).

CONGRIDAE

Conger. *Conger conger* (Linn.) = *C. vulgaris*, Day.

SYNAPHOBANCHIDAE

Synaphobranchus pinnatus (Gronow).
Nettophichthys retropinnatus, Holt.

Order HETEROMI

NOTACANTHIDAE

Notacanthus bonaparti, Risso.
Macdonaldia rostrata (Collett).

Order SYNENTOGNATHI

SCOMBERESOCIDAE

Skipper or Saury. *Scomberesox saurus* (Walbaum).

BELONIDAE

Garfish. *Belone belone* (Linn.) = *B. vulgaris*, Day.

EXOCOETIDAE

- Flying-fish. *Exocoetus volitans*, Linn.
 „ *Exocoetus evolvans* (Linn.).

Order SOLENICHTHYES

MACRORAMPHOSIDAE

- Trumpet-fish. *Macroramphosus scolopax*, Linn. = *Centriscus scolopax*, Day.

SYNGNATHIDAE

- Snake Pipe-fish. *Entelurus aequoreus* (Linn.) = *Nerophis aequoreus*, Day.
 Straight-nosed Pipe-fish. *Nerophis ophidion* (Linn.).
 Worm Pipe-fish. *Nerophis lumbriciformis* (Yarrell).
 Great Pipe-fish. *Syngnathus acus*, Linn.
Syngnathus rostellatus, Nilsson.
 Broad-nosed Pipe-fish. *Siphonostoma typhle* (Linn.).
 Sea Horse. *Hippocampus hippocampus* (Linn.) = *H. antiquorum*, Day.

Order ANACANTHINI

MACRURIDAE

- Coryphaenoides rupestris*, Gunner.
 „ *murrayi*, Günther.
Coelorhynchus coelorhynchus (Risso).
 „ *labiatus* (Koehler).
Lionurus aequalis (Günther).
 „ *guentheri* (Vaillant).
Malacocephalus laevis (Lowe).
Nematonurus farrani, Brunner.
Trachyrhynchus trachyrhynchus (Risso).
 „ *murrayi*, Günther.
Lyconus brachycolus, Holt and Byrne.
Bathygadus melanobranchus (Vaillant).

MERLUCCIIDAE

- Hake. *Merluccius merluccius* (Linn.) = *M. vulgaris*, Day.

GADIDAE

- Cod. *Gadus callarias* (Linn.) = *G. morrhua*, Day.
 Haddock. *Gadus aeglefinus*, Linn.
 Bib. *Gadus luscus*, Linn.
 Poor Cod. *Gadus minutus*, Linn.
 Whiting. *Gadus merlangus*, Linn.
 Poutassou. *Gadus poutassou* (Risso).
 Norway Pout. *Gadus esmarkii*, Nilsson.
 Coal-fish. *Gadus virens*, Linn.
 Pollack. *Gadus pollachius*, Linn.
 Silvery Pout. *Gadiculus argenteus*, Guich.
 Greater Fork-beard. *Urophycis blennoides* (Brünnich) = *Phycis blennoides*, Day.
Urophycis chuss (Walbaum).
Laemonema latifrons, Holt and Byrne.
 Burbot. *Lota lota* (Linn.) = *L. vulgaris*, Day.
 Ling. *Molva molva* (Linn.) = *M. vulgaris*, Day.
 Blue Ling. *Molva byrkelange*, Walbaum.
 Mediterranean Ling. *Molva elongata*, Risso.
Mora mediterranea, Risso.
Lepidion eques (Günther).
Antimora viola (Goode and Bean).
Halargyreus affinis, Collett.
 Five-bearded Rockling. *Onos mustelus* (Linn.) = *Motella mustela*, Day.
 Four-bearded Rockling. *Onos cimbrius* (Linn.) = *Motella cimbria*, Day.
 Three-bearded Rockling. *Onos tricirratus* (Bloch) = *Motella tricirrata*, Day.
 Lesser Fork-beard. *Raniceps raninus* (Linn.).
 Torsk. *Brosme brosme* (Müller) = *Brosmius brosme*, Day.

Order ALLOTRIOGNATHI

LAMPRIDIDAE

- Opah. *Lampris luna* (Gmelin).

TRACHYPTERIDAE

- Deal-fish. *Trachypterus arcticus* (Brünnich).
 Oar-fish. *Regalecus glesne* (Ascanius) = *R. banksii*, Day.

Order BERYCOMORPHI

*BERYCIDAE**Beryx splendens*, Lowe.,, *decadactylus*, Cuvier and Valenciennes.*DIRETMIDAE**Diretmus argenteus*, Johnson.*TRACHICHTHYIDAE**Hoplostethus mediterraneus*, Cuvier and Valenciennes.,, *atlanticus*, Collett.*MELAMPHAIDAE**Melamphaes megalops*, Lütken... *beanii*, Günther.

Order ZEOMORPHI

*ZEIDAE*John Dory. *Zeus faber*, Linn.*Cyttosoma helgae*, Holt and Byrne.*CAPROIDAE*Boar-fish. *Capros aper* (Linn.).

Order PERCOMORPHI

*SERRANIDAE*Bass. *Morone labrax* (Linn.) = *Labrax lupus*, Day.Stone Basse. *Polyprion americanus* (Schneider) = *P. cernium*, Day.Dusky Perch. *Epinephelus gigas* (Brünnich) = *Serranus gigas*, Day.Comber. *Serranus cabrilla* (Linn.).*CHILODIPTERIDAE**Epigonus telescopus*, Risso.*PERCIDAE*Perch. *Perca fluviatilis*, Linn.Pope or Ruffe. *Acerina cernua* (Linn.) = *A. vulgaris*, Day.

CARANGIDAE

Horse Mackerel. *Trachurus trachurus* (Linn.) = *Caranx trachurus*, Day.

Pilot-fish. *Naucrates ductor* (Linn.).

Glaucus. *Trachinotus glaucus* (Linn.) = *Lichia glauca*, Day.

BRAMIDAE

Ray's Bream. *Brama raii* (Bloch).

Brama longipinnis, Lowe.

SCIAENIDAE

Meagre. *Sciaena aquila*, Risso.

* MULLIDAE

Red Mullet. *Mullus surmuletus*, Linn. = *M. barbatus*, Day.

SPARIDAE

Dentex. *Dentex dentex* (Gmelin) = *D. vulgaris*, Day.

Common Sea Bream. *Pagellus centrodontus* (De la Roche).

Spanish Bream. *Pagellus bogaraveo* (Brünnich).

Axillary Bream. *Pagellus owenii*, Günther.

Pagellus acarne (Risso).

Pandora. *Pagellus erythrinus* (Linn.).

Black Bream. *Spondylusoma cantharus* (Gmelin) = *Cantharus lineatus*, Day.

Bogue. *Box boops* (Linn.) = *B. vulgaris*, Day.

Gilt-head. *Sparus aurata*, Linn. = *Pagrus auratus*, Day.

Couch's Sea Bream. *Pagrus pagrus* (Linn.) = *P. vulgaris*, Day.

CEPOLIDAE

Red Band-fish. *Cepola rubescens*, Linn.

LABRIDAE

Rainbow Wrasse. *Coris julis* (Linn.).

Ballan Wrasse. *Labrus bergylla*, Ascanius = *L. maculatus*, Day.

Cuckoo Wrasse. *Labrus mixtus*, Linn.

Gilt-head. *Crenilabrus melops* (Linn.).

Gold-sinny. *Ctenolabrus rupestris* (Linn.).

Scale-rayed Wrasse. *Acantholabrus palloni* (Risso).

Rock Cook. *Centrolabrus exoletus* (Linn.).

AMMODYTIDAE

Greater Sand Eel. *Ammodytes lanceolatus*, Lesauvage.

Lesser Sand Eel. *Ammodytes tobianus*, Linn.

Ammodytes cicerellus, Rafinesque.

„ *marinus*, Raitt.

TRACHINIDAE

Greater Weever. *Trachinus draco*, Linn.

Lesser Weever. *Trachinus vipera*, Cuvier and Valenciennes.

GEMPYLIDAE

Ruvettus pretiosus, Cocco.

Nesiarchus nasutus, Johnson.

TRICHIURIDAE

Hair-tail. *Trichiurus lepturus*, Linn.

Scabbard-fish. *Lipidopus caudatus* (Euphrasen).

Aphanopus carbo, Lowe.

SCOMBRIDAE

Mackerel. *Scomber scombrus*, Linn.

Spanish Mackerel. *Pneumatophorus colias* (Gmelin) = *Scomber colias*, Day.

Tunny. *Thunnus thynnus* (Linn.) = *Orcynus thynnus*, Day.

Long-finned Tunny. *Germo alalunga* (Gmelin) = *Orcynus germo*, Day.

Bonito. *Katsuwonus pelamis* (Linn.) = *Thynnus pelamys*, Cuvier and Valenciennes.

Pelamid. *Sarda sarda* (Bloch) = *Pelamys sarda*, Day.

Plain Bonito. *Auxis rochei* (Risso).

LUVARIDAE

Luvarus imperialis, Rafinesque.

XIPHIIDAE

Sword-fish. *Xiphias gladius*, Linn.

ISTIOPHORIDAE

Sail-fish. *Istiophorus americanus*, Cuvier and Valenciennes.

GOBIIDAE

- Giant Goby. *Gobius capito*, Cuvier and Valenciennes.
 Black Goby. *Gobius niger*, Linn.
 Rock Goby. *Gobius paganellus*, Gmelin.
 Fries's Goby. *Gobius friesii*, Malm.
 Spotted Goby. *Gobius ruthensparri*, Euphrasen.
 Painted Goby. *Gobius pictus*, Malm.
 Common Goby. *Gobius minutus*, Gmelin.
 Jeffrey's Goby. *Gobius jeffreysii*, Günther.
Gobius orca, Collett.
 Diminutive Goby. *Gobius scorpioides*, Collett.
 Transparent Goby. *Aphia minuta* (Risso) = *A. pellucida*, Day.
Crystallogobius nilssonii (Düben and Koren).

CALLIONYMIDAE

- Dragonet. *Callionymus lyra*, Linn.
 Spotted Dragonet. *Callionymus maculatus*, Rafinesque.

BLENNIIDAE

- Gattorugine. *Blennius gattorugine*, Bloch.
 Montagu's Blenny. *Blennius montagui*, Fleming = *B. galerita*, Day.
 Butterfly Blenny. *Blennius ocellaris*, Linn.
 Shanny. *Blennius pholis*, Linn.
 Yarrell's Blenny. *Chirolophis galerita* (Linn.) = *C. ascanii*, Day.

CLINIDAE

- Parviclinus spinosus*, Brunner.

LUMPENIDAE

- Lumpenus lampetraeformis* (Walbaum).

PHOLIDAE

- Butter-fish. *Pholis gunnellus*, Linn. = *Centronotus gunnellus*, Day.

ZOARCIDAE

- Viviparous Blenny. *Zoarces viviparus* (Linn.).

ANARHICHADIDÆ

- Cat-fish. *Anarhichas lupus*, Linn.
Anarhichas minor, Olafsen.
 „ *latifrons*, Steenstrup and Hallgrimsson.

OPHIDIIDÆ

- Ophidion barbatum*, Linn.

FIERASFERIDÆ

- Fierasfer. *Fierasfer dentatus*, Cuvier.
Fierasfer acus (Brünnich).

STROMATEIDÆ

- Black-fish. *Centrolophus niger* (Gmelin) = *C. pompilus*, Day.
 Cornish Black-fish. *Centrolophus britannicus*, Günther.
 Barrel-fish. *Leirus medusophagus* (Cocco).
 „ „ *Leirus perciformis* (Mitchell) = *Pammelas perciformis*,
 Day. •

MUGILIDÆ

- Thick-lipped Grey Mullet. *Mugil chelo*, Cuvier.
 Thin-lipped Grey mullet. *Mugil capito*, Cuvier.
 Golden Grey Mullet. *Mugil auratus*, Risso.

ATHERINIDÆ

- Sand Smelt. *Atherina presbyter*, Cuvier.
Atherina boyeri, Risso.

Order SCLEROPAREI

SCORPAENIDÆ

- Norway Haddock. *Sebastes marinus* (Linn.) = *S. norvegicus*, Day.
Sebastes viviparus, Krøyer.
Scorpaena cristulata, Goode and Bean.
 „ *scrofa*, Linn.
Helicolenus microphthalmus, Norman.
 „ *dactylopterus* (De la Roche) = *Scorpaena dactyloptera*,
 De la Roche.

TRIGLIDAE

- Tub-fish. *Trigla lucerna*, Linn. = *T. hirundo*, Day.
 Red Gurnard. *Trigla cuculus*, Linn. = *T. pini*.
 Grey Gurnard. *Trigla gurnardus*, Linn.
 Streaked Gurnard. *Trigla lineata*, Gmelin.
 Shining or Long-finned Gurnard. *Trigla obscura*, Linn.
 Piper. *Trigla lyra*, Linn.
 Armed Gurnard. *Peristedion cataphractum* (Linn.) = *Peristethus cataphractum*, Linn.

COTTIDAE

- Miller's Thumb. *Cottus gobio*, Linn.
 Father Lasher. *Cottus scorpius*, Linn.
 Long-spined Sea Scorpion. *Cottus bubalis*, Euphrasen.
 Four-horned Cottus. *Cottus quadricornis*, Linn.
Cottunculus thomsonii (Günther).
Triglops murrayi, Günther.

AGONIDAE

- Armed Bullhead. *Agonus cataphractus* (Linn.).

CYCLOPTERIDAE

- Lump-sucker. *Cyclopterus lumpus*, Linn.

LIPARIDAE

- Sea Snail. *Liparis liparis* (Linn.) = *L. vulgaris*, Day.
 Montagu's Sea Snail. *Liparis montagui* (Donovan).

GASTEROSTEIDAE

- Three-spined Stickleback. *Gasterosteus aculeatus*, Linn.
 Ten-spined Stickleback. *Pygosteus pungitius* (Linn.) = *Gasterosteus pungitius*, Day.
 Fifteen-spined Stickleback. *Spinachia spinachia* (Linn.) = *Gasterosteus spinachia*, Day.

Order HETEROSOMATA

BOTHIDAE

- Grohmann's Scald-fish. *Arnoglossus thori*, Kyle = *A. grohmanni*, Bonaparte.
 Scald-fish. *Arnoglossus laterna* (Walbaum).

Arnoglossus imperialis (Rafinesque).

Turbot. *Scophthalmus maximus* (Linn.) = *Rhombus maximus*, Day.

Brill. *Scophthalmus rhombus* (Linn.) = *Rhombus laevis*, Day.

Megrim. *Lepidorhombus whiffiagonis* (Walbaum) = *Arnoglossus megastoma*, Day.

Lepidorhombus boscii (Risso).

Norwegian Topknot. *Phrynorhombus norvegicus* (Günther).

Eckstrom's Topknot. *Phrynorhombus regius* (Bonnaterre) = *Zeugopterus unimaculatus*, Day.

Common Topknot or Bloch's Topknot. *Zeugopterus punctatus* (Bloch).

PLEURONECTIDAE

Halibut. *Hippoglossus hippoglossus* (Linn.) = *H. vulgaris*, Day.

Greenland Halibut. *Reinhardtius hippoglossoides* (Walbaum).

Long Rough Dab. *Hippoglossoides platessoides* (Fabricius) = *H. limandoides*, Day.

Dab. *Limanda limanda* (Linn.) = *Pleuronectes limanda*, Day.

Plaice. *Pleuronectes platessa*, Linn.

Lemon Sole. *Microstomus kitt* (Walbaum) = *Pleuronectes microcephalus*, Day.

Witch. *Glyptocephalus cynoglossus* (Linn.) = *Pleuronectes cynoglossus*, Day.

Flounder. *Platichthys flesus* (Linn.) = *Pleuronectes flesus*, Day.

SOLEIDAE

Dicologlossa azevia (Capello).

Sole. *Solea solea* (Linn.) = *S. vulgaris*, Day.

Sand Sole. *Pegusa lascaris* (Risso) = *Solea lascaris*, Day.

Bathysolea profundicola (Vaillant).

Thickback Sole. *Microchirus variegatus* (Donovan) = *Solea variegata*, Day.

Solenette. *Microchirus boscanion* (Chabanaud) = *Solea lutea*, Day.

Order DISCOCEPHALI

ECHENEIDIDAE

Remora. *Remora remora* (Linn.) = *Echeneis remora*, Day.

Order PLECTOGNATHI

BALISTIDAE

Trigger-fish. *Balistes capriscus*, Gmelin.

Balistes maculatus, Gmelin.

TETRODONTIDAE

Globe-fish. *Lagocephalus lagocephalus* (Linn) = *Tetrodon lagocephalus*, Day.

MOLIDAE

Sun-fish. *Mola mola* (Linn.) = *Orthogoriscus mola*, Day.

Truncated Sun-fish. *Ransania truncata* (Retzius) = *Orthogoriscus truncata*, Day.

Order XENOPTERYGII

GOBIESOCIDAE

Cornish Sucker. *Lepadogaster gouani*, Lacepède.

Connemara Sucker. *Lepadogaster candollei*, Risso.

Two-spotted Sucker. *Lepadogaster bimaculatus* (Bonnaterre).

Small-headed Sucker. *Lepadogaster microcephalus*, Brook.

Order PEDICULATI

LOPHIIDAE

Angler. *Lophius piscatorius*, Linn.

Dibranchius atlanticus, Peters.

ONEIRODIDAE

Dolopichthys megaceros, Holt and Byrne = *Oneirodes megaceros*, Holt and Byrne.

Dolopichthys inimicus, Brunner.

„ *hibernicus*, Brunner.

GIGANTACTINIDAE

Gigantactis filibulbosus, Brunner.

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INDEX.

- Abramis brama*, 299. Plate 126
 Abyssal fish, 30
abyssorum, Molva, 30
Acanthias vulgaris, 320, 321. Plate 131
Acantholabrus palloni, 130
Acerina vulgaris, 34, 385. Plate 1
Acipenser sturio, 305. Plate 108
 ACIPENSERIDAE, 305, 378
aculeatus, *Gasterosteus*, 124. Plate 7
acus, *Fierasfer*, 168
acus, *Syngnathus*, 208. Plate 84
aeglefinus, *Gadus*, 141. Plate 55
aequalis, *Lionurus*, 359
aequoreus, *Nerophis*, 208. Plate 84 ;
Entelurus, 383
affinis, *Halargyreus*, 358, 384
 AGONIDAE, 55, 390
Agonus cataphractus, 55. Plate 25 ;
 eggs, Plate 14
 Agriculture and Fisheries, Ministry
 of, 31, 136, 144
 Air-bladder, 14
alalunga, *Germo*, 387
Albacore, 65. Plate 20
alba, *Raja*, 335. Plate 130
Alburnus lucidus, 302. Plate 124
 ALEPISAUROIDAE, 365, 381
Alepisaurus ferox, 365, 381
 ALEPOCEPHALIDAE, 366, 379
Alepocephalus giardii, 30, 367 ; *macro-*
pterus, 367 ; *rostratus*, 366
Alevin, 219
Allis Shad, 263. Plate 110
 ALLOTRIOGNATHI, 384
Alopias vulpes, 313. Plate 121
alosa, *Clupea*, 263. Plate 110
altior, *Coregonus*, 242
americanus, *Istiophorus Polyprion*, 36
Ammocoetes branchialis, 346. Plate 136
Ammodytes cicereillus, 361 ; *lancoolatus*,
 166, Plate 64 ; *marinus*, 361 ;
tobianus, 166, Plate 64 ; eggs, Plate 106
 AMMODYTIDAE, 165, 361, 387
 ANACANTHINI, 357, 383
 Anadromous, 9, 215
 ANARHICHADIDAE, 109, 357, 389
Anarhichas latifrons, 357 ; *minor*, 110 ;
lupus, 109, Plate 42 ; eggs, Plate 43
 Anchovy, 265. Plate 117
 Angel-fish, 328. Plate 127
 Angler, 57. Plate 18
Anguilla latirostris, 268 ; *rostrata*,
 272 ; *vulgaris*, 267, Plate 111
 ANGUILLIDAE, 266, 382
anguineus, *Chlamydoselachus*, 374, 376
Antimora viola, 358, 384
antiquorum, *Hippocampus*, 210. Plate 84
aper, *Capros*, 81. Plate 28
Aphanophus carbo, 30
Aphia minuta, 97, 388
Aphya pellucida, 97, 388
 APODES, 371, 382
aquila, *Myliobatis*, 342
aquila, *Sciaena*, 84. Plate 32
arcticum, *Myctophum*, 363, 381
arcticus, *Trachypterus*, 118. Plate 47
argenteola, *Couchia*, 163
argenteus, *Directmus*, 353, 385
argenteus, (*Gadiculus*) *Gadus*, 154
Argentina silus, 248 ; *sphyraena*, 248,
 Plate 26
 Argentine, 248. Plate 26
 ARGENTINIDAE, 248, 365, 380
Argyropelecus hemigymnus, 215, 368,
 379 ; *olfersii*, 369, 379
 Armed bullhead, 55. Plate 25 ; eggs,
 Plate 14
 Armed gurnard, 57

- Arnoglossus grohmanni*, 205; *imperialis*, 204; *laterna*, 203, Plate 81; *megastoma*, 202, Plate 78; *thori*, 205
- Artificial hatching, 16
- ascanii*, *Carelophus*, 108
- Astronesthes niger*, 369, 379
- ASTRONESTHIDAE, 369, 379
- Atherina boyeri*, 121; *presbyter*, 121, Plate 51
- ATHERINIDAE, 121, 389
- atlantica*, *Rhinochimaera*, 375, 378
- atlanticus*, *Bathylagus*, 365; *Dibranchius*, 355, 392
- atlanticus*, *Hoplostethus*, 353, 385
- auratus*, *Carassius*, 285
- auratus*, *Pagrus*, 41
- Auxis rochei*, 67
- Avocettina infans*, 371, 382
- Axillary bream, 40-42
- Azevia, 194; *azevia*, *Dicologlossa*, 362, 391; *Solea*, 194
- Azurine, 298
- Bacillus salmonis pestis*, 225
- Balistes capriscus*, 210, Plate 86; *maculatus*, 391
- BALISTIDAE, 210, 391
- banksii*, *Regalecus*, 120. Plate 47
- Banks' oar-fish, 120. Plate 47
- barbatula*, *Cobitis*, 305. Plate 116
- barbatum*, *Ophidium*, 168. Plate 64
- Barbel, 286. Plate 115
- Barbus fluviatilis*, 286, Plate 115; *tor*, 283
- Barrel fish, 70, Plate 27; *Portrush*, 72, Plate 23
- Basking shark, 314. Plate 122
- Bass, 34. Plate 2; *scale*, Plate 11
- Basse, Stone, 36. Plate 2
- Bathygadus melanobranchus*, 359, 383
- Bathylagus atlanticus*, 365; *euryops*, 366; *glacialis*, 365
- Bathypelagic*, 249
- bathypophilus*, *Gonostoma*, 367, 379
- Bathypterois dubius*, 362, 381
- Bathysolea profundicola*, 362, 391
- Bathytroctes rostratus*, 367, 379
- batis*, *Raja*, 334. Plate 133
- beani*, *Melamphaes*, 353, 385; *Serrivomer*, 371, 382
- Bearded ophidium, 168. Plate 64
- Beaumaris shark, 312. Plate 129
- Belone vulgaris*, 249. Plate 102
- BELONIDAE, 249, 382
- bergylta*, *Labrus*, 128. Plate 52
- BERYCIDAE, 352, 385
- BERYCOMORPHI, 352, 385
- Beryx decadactylus*, 352, 385; *splendens*, 352, 385
- Bib, 148. Plate 54
- bifilis*, *Diplolechnus*, 369, 379
- bimaculatus*, *Lepadogaster*, 107. Plate 40
- bjoernka*, *Blicca*, 298. Plate 124
- Black-finned trout, 227
- Black fishes, 68. Plate 26
- blackfordi*, *Yarrella*, 368, 379
- Black goby, 91. Plate 42
- Black-mouthed dogfish, 319. Plate 122
- Black tails, 230
- Blade fish, 85. Plate 33
- Bleak, 302. Plate 124
- BLENNIDAE, 108, 388
- Blennius galerita*, 111, Plate 45; *gattorugine*, 110, Plate 44; *ocellaris*, 111, Plate 44; *pholis*, 112, Plate 45
- blennoides*, *Phycis*, 160, Plate 61; *Urophycis*, 384
- Blicca*, *bjoernka*, 298. Plate 124
- Bloch's Topknot, 206, 357
- Blue dogfish, 309
- Blue shark, 307. Plate 118
- boa*, *Stomias*, 370, 379
- Boar fish, 81. Plate 28
- bogaroveo*, *Sparus*, 42
- Bogue, 41
- Ballan wrasse, 128. Plate 52
- Bonito, 66; *plain*, 67
- Borer, 348
- boscannon*, *Microchirus*, 391
- boscii*, *Lepidorhombus*, 361
- BOTHIDAE, 361, 390
- Box vulgaris*, 41
- boyeri*, *Atherina*, 121. Plate 51
- brachycolus*, *Lyconus*, 360, 383
- brachypoma*, *Salmo*, 227
- brama*, *Abramis*, 299. Plate 126
- Brama longipinnis*, 75; *raii*, 74, Plate 22
- BRAMIDAE, 74, 386

Branchial arches, 7
branchialis, *Ammocaetes*, 346, Plate 136
 Bream, 299, Plate 126; white or silver, Plate 124
 Breasts, sea, 40
 Brill, 201. Plate 83
britannicus, *Centrolophus*, 70, 389
 Broad-nosed eel, 267
 Broad-nosed pipe fish, 208. Plate 84
 Brook trout, 231. Plate 98
brosme, *Brosmius*, 164. Plate 62
Brosmius brosmie, 164. Plate 62
bubalis, *Cottus*, 48. Plate 8
 Bullhead, 47. Plate 7
 Bull trout, 230
 Burbot, 161. Plate 60
 Butter fish, 114, Plate 49; eggs, Plate 48
 Butterfly blenny, 111. Plate 44
byrkelange, *Molva*, 384

Cabrilla, *Serranus*, 35. Plate 6
calceus, *Centrophorus*, 323, 377
 CALLIONYMIDAE, 98, 388
Callionymus lyra, 99, Plate 34; *maculatus*, 100, Plate 36
cambricus, *Salmo*, 227
canicula, *Scyllium*, 318. Plate 131
caniculus, *Scylliorhinus*, 377
Cantharus lineatus, 41. Plate 5
capito, *Gobius*, 90, 388. Plate 87
capito, *Mugil*, 123, 389
caprisus, *Balistes*, 210. Plate 86
 CAPROIDAE, 81, 385
Capros aper, 81. Plate 28
 CARANGIDAE, 77, 386
Caranx trachurus, 78. Plate 25
Carassius auratus, 285; *vulgaris*, 284, Plate 114
Carcharias glaucus, 307. Plate 118
 CARCHARINIDAE, 306, 377
Carcharinus glaucus, 377
Carelophus ascanii, 108
 Carp, common, 282, Plate 113; crucian, 284, Plate 114
carpio, *Cyprinus*, 282. Plate 113
 Catadromous, 9
cataphractum, *Peristedion*, 390; *Peristedius*, 57, 390

cataphractus, *Agonus*, 55, Plate 25; eggs, Plate 14
 Cat-fish, 109, Plate 42; eggs, Plate 43
catulus, *Scyllium*, 318. Plate 131
caudatus, *Lepidopus*, 86. Plate 33
caudatus, *Trichiurus*, 85. Plate 33
 Caviare, 305
centrina, *Oxymotus*, 373, 377
Centrina salviani, 320
 CENTRISCIDAE, 126
Centriscus scolopax, 126
centrodontus, *Sparus*, 40. Plate 1
Centrolabrus exoletus, 131, 38
Centrolophus britannicus, 70 *niger*, 69, Plate 26
Centronotus gunnellus, 114. Plate 49
Centrophorus calceus, 323; *squamosus*, 323
Cephalacanthus, 55
Cepola rubescens, 117. Plate 46
 CEPOLIDAE, 117, 386
Cephaloptera giornae, 343
cephalus, *Leuciscus*, 292, Plate 107; *Squalius*, 381
cernium, *Polypridn*, 36, 385
cernua, *Acerina*, 34. Plate 1
 Char, 234, Plate 99; blunt-nosed, 239; Cole's, 238; Coomasaharn, 239; Gray's, 238; Large-mouthed, 238; Loch Killin, 237; Lonsdale's, 237; Malloch's, 238; Orkney, 238; Scharff's, 239; Shetland, 238; Struan, 237; Trevelyan's, 239; Willoughby's, 236
chavest, *Lampadena*, 365, 381
chelo, *Mugil*, 123. Plate 50
 CHILODIPTERIDAE, 354, 385
Chimaera mirabilis, 350; *monstrosa*, 349, Plate 143
 CHIMAERIDAE, 349, 375, 378
Chirolophis galerita, 112. Plates 45, 49
 CHLAMYDOSELACHIDAE, 374, 376
Chlamydoselachus anguineus, 374, 376
 CHONDROSTEI, 378
 Chub, 292. Plate 107
chuss, *Urophycis*, 358, 384
cimbria, *Motella*, 163. Plate 58
circularis, *Raja*, 337. Plate 135
clavatu, *Raja*, 338. Plate 134
 CLINIDAE, 357, 388

- Clupea alosa*, 263, Plate 110; *finta*, 264, Plate 104; *harengus*, 256, Plate 109; eggs, Plate 106; *pilchardus*, 262, Plate 117; *sprattus*, 261, Plate 117
- CLUPEIDAE, 255, 379
- Coal-fish, 149. Plate 58
- COBITIDAE, 303, 382
- Cobitis barbatula*, 305, Plate 116; *taenia*, 305, Plate 116
- Cod, 134. Plate 55
- Codling, 140
- Coelorhynchus coelorhynchus*, 359, 383; *labiatus*, 359, 383
- Cole's char, 238
- colias*, *Pneumatophorus*, 387; *Scomber*, 63, Plate 16
- Comber, 35. Plate 6
- Common bream, 299, Plate 126; carp, 282, Plate 113; sea-bream, 40, Plate 9; sea snail, 105, Plate 38; eggs, 106, Plate 53
- Conger, 273. Plate 112
- CONGRIDAE, 273, 382
- Connemara sucker, 107. Plate 40
- Cook, Rock, 131
- coregonoides*, *Paralepis*, 215, 362, 381
- Coregonus altior*, 242; *clupeioides*, 242, Plate 103; *elegans*, 242; *gracilior*, 241; *lavaretus*, 242, Plate 103; *oxyrhynchus*, 244, Plate 104; *pennantii*, 243, Plate 100; *pollan*, 241, Plate 103; *stigmaticus*, 243
- vandesius*, 240, Plate 100
- Coris julis*, 131. Plate 52
- Corkwing, 129. Plate 52
- Cornish black-fish, 70
- Cornish sucker, 107. Plate 40
- cornubica*, *Lamna*, 311. Plate 129
- CORYPHAENOIDIDAE, 73, 358
- Coryphaenoides murrayi*, 359; *ruprestris*, 30, 359, 383
- COTTIDAE, 45, 355, 390
- Cottunculus thomsonii*, 355, 390
- Cottus bubalis*, 48, Plate 8; *gobio*, 46, Plate 7; *quadricornis*, 49, Plate 50; *scorpius*, 47, Plate 10; eggs, Plates 37, 48
- Couchia argenteola*, 163
- Crenilabrus melops*, 129. Plate 52
- crisulata*, *Scorpaena*, 354, 389
- crocodilus*, *Lampanyctus*, 364, 381
- Crucian carp, 284. Plate 114
- Crystallogobius nilsonii*, 98, 388
- Ctenolabrus ruprestris*, 130, 386
- Cuckoo-fish, 81. Plate 28
- Cuckoo-wrasse, 129. Plate 52
- cuculus*, *Trigla*, 51. Plate 12
- Cyclogaster liparis*, 105, Plate 38; eggs, Plate 35; *montagui*, 105, Plate 38
- CYCLOPTERIDAE, 101, 390
- Cyclopterus lumpus*, 101, Plates 39, 41; eggs, Plate 37
- Cyclostomata, 343
- Cyclothone microdon*, 367, 379
- cynoglossus*, *Glyptocephalus*, 391, Plate 70; *Pleuronectes*, 184, Plate 70
- CYPRINIDAE, 276, 381
- Cyprinus carpio*, 282. Plate 113
- CYTTIDAE, 82
- Cyttosoma helgae*, 356, 385
- Dab, 185, Plate 71; otolith, Plate 11; long rough, 191, Plate 75
- Dace, 294. Plate 107
- dactylopterus*, *Helicolenus*, 354, 389; *Scorpaena*, 43, 354, 389
- "Darkie Charlie," 326
- Deal-fish, 118. Plate 47
- decadactylus*, *Beryx*, 352, 385
- decandolii*, *Lepadogaster*, 107. Plate 40
- Demersal eggs, 8, 9
- dentatus*, *Fierasfer*, 168, 389
- Dentex vulgaris*, 36, 386
- diaphana*, *Sternoptyx*, 368, 379
- Diaphus dosleini*, 364; *dumerili*, 364; *rafinesquei*, 364
- Dibranchus atlanticus*, 355, 392
- Dicologlossa azevia*, 362, 391
- Diplolychnus bifilis*, 369, 379
- DIRETMIDAE, 353, 385
- Diretmus argenteus*, 353, 385
- DISCOCEPHALI, 391
- Doctor-fish, 290
- dosleini*, *Diaphus*, 364, 381
- Dogfish, 317, 321, Plate 331; eggs, 318, Plate 43
- Dog-salmon, 216
- Dolopichthys hibernicus*, 355; *inimicus*, 355, 392; *megaceros*, 355, 392
- Dolphins, 73

- Dory, John, 82. *Plate* 31
 Double-spotted sucker, 107. *Plate* 40
draco, *Trachinus*, 59. *Plate* 3
 Dragonet, 99, *Plate* 34; spotted, 100, *Plate* 36
dubius, *Bathypterois*, 362, 381
ductor, *Naucrates*, 79. *Plate* 27
dumerili, *Diaphus*, 364, 381
 Dusky perch, 36
- Eagle rays, 342
ECHENEIDIDAE, 391
Echeneis remora, 68. *Plate* 24
Echinorhinus spinosus, 327. *Plate* 125
 Eel, 267. *Plate* 111
 Eggs, demersal, 8, 9; planktonic, 8, 9
 Electric ray, 329. *Plate* 128
elegans, *Coregonus*, 242, 380
elongatus, *Lampanyctus*, 364, 381
 Elver, 268
encrasicholus, *Engraulis*, 265. *Plate* 117
Engraulis encrasicholus, 265. *Plate* 117
Entelurus aequoreus, 383
eperlanus, *Osmerus*, 247. *Plate* 92
Epigonus telescopus, 354, 385
Epinephelus gigas, 385
eques, *Lepidion*, 358, 384
erythrinus, *Sparus*, 42
erythrophthalmus, *Scardinius*, 297. *Plate* 123
esmarki, *Gadus*, 151. *Plate* 56
ESOCIDAE, 252, 381
Esox lucius, 253. *Plates* 95, 108
Eugaleus galeus, 377
euryops, *Bathylagus*, 366, 380
evolans, *Exocoetus*, 252
EXOCOETIDAE, 252, 383
Exocoetus evolans, 252; *volitans*, 251, *Plate* 105
exoletus, *Centrolabrus*, 131; *Labrus*, 131
- Faber*, Zeus, 82. *Plate* 31
fario, *Salmo*, 227. *Plates* 94, 95, 96, 97
farrani, *Nematomurus*, 360, 383
 Father-lasher, 47. *Plate* 10
- ferox*, *Alepisaurus*, 365, 381; *Salmo*, 227; *Saprolegnia*, 225
 Fiddle fish, 328. *Plate* 127
Fierasfer acus, 168; *dentatus*, 168
FIERASFERIDAE, 168, 389
 Fifteen-spined stickleback, 125, *Plate* 36; nest, *Plate* 53
 File-fish, 210. *Plate* 86
filibulbosus, *Gigantactis*, 355, 392
 Finnon haddock, 141
 Fin rays, 281
 Fins, 2
finta, *Clupea*, 264. *Plate* 104
 Fish, external features, 2
 Five-bearded rockling, 163. *Plate* 63
flagellibarba, *Lamprotopus*, 371, 379
 Flapper skate, 340. *Plate* 140
flesus, *Platichthys*, 391; *Pleuronectes*, 187, *Plate* 72; eggs, *Plate* 73; food, *Plate* 67
 Flounder, 187, *Plate* 72; eggs, *Plate* 73; food, *Plate* 67
fluviatilis, *Barbus*, 286, *Plate* 115; *Gobio*, 288, *Plate* 116; *Perca*, 33, *Plate* 1; eggs, *Plate* 66; *Petromyzon*, 345, *Plate* 136
 Flying fish, 251. *Plate* 105
fontinalis, *Salvelinus*, 231. *Plate* 98
 Fork-beard, greater, 160, *Plate* 61; lesser, 162, *Plate* 62
fossilis, *Misgurnus*, 304
 Four-bearded rockling, 163. *Plate* 58
 Four-horned cottus, 49. *Plate* 50
 Fox shark, 313. *Plate* 121
 French sole, 197. *Plate* 79
 Fresh-water herring, 243
 Fries' Goby, 93. *Plate* 29
 Frog-mouthed eel, 267
fullonica, *Raja*, 337. *Plate* 132
fyllae, *Raja*, 375, 378
- Gadiculus argenteus*, 154, 384
GADIDAE, 131, 357, 384
Gadus aeglefinus, 141, *Plate* 55; *argenteus*, 154; *esmarki*, 151, *Plate* 56; *luscus*, 148, *Plate* 54; *merlangus*, 150, *Plate* 57; *minutus*, 148, *Plate* 54; *morrhua*, 134, *Plate* 55; *pollachius*, 152, *Plate* 57; *poutassou*, 153, *Plate* 56; *virens*, 149, *Plate* 58

- galerita*, *Blennius*, 111, Plate 45;
Chirolophis, 112, Plates 45, 49
galeus, *Eugaleus*, 377
Galeus vulgaris, 308, Plate 129
gallivensis, *Salmo*, 227
Gaper, 36
Gar-fish, 249, Plate 102; eggs,
 Plate 35
Gar-pike, 249, Plate 102
 GASTEROSTEIDAE, 124, 390
Gasterosteus aculeatus, 124, Plate 7;
pungitius, 125, Plate 7; *spinachia*,
 125, Plate 36; nest, 126, Plate 53
Gattorugine, 110, Plate 44
gattorugine, *Blennius*, 110, Plate 44
Gemmeous dragonet, 99
gemmifer, *Lampanyctus*, 364, 381
 GEMPYLIDAE, 355, 387
Germo alalunga, 387
germo, *Thynnus*, 65, Plate 20
Giant goby, 90
giardi, *Alepocephalus*, 367, 379
 GIGANTACTINIDAE, 392
Gigantactis filibulbosus, 355, 392
gigas, *Epinephelus*, 385; *Serranus*, 35
Gillaroo, 227, 231
Gilt-head, 40, 41
giornae, *Cephaloptera*, 343, 378
glaciale, *Myctophum*, 363, 381
glacialis, *Bathylagus*, 365, 380
gladius, *Xiphias*, 83, Plate 28
glauca, *Lichia*, 80
Glaucus, 80
glaucus, *Carcharias*, 307, Plate 118;
Trachinotus, 386
glesne, *Regalecus*, 120, Plate 47
Globe-fish, 211
glutinosa, *Myxine*, 348
Glutinous hag, 348
Glyptocephalus cynoglossus, 391
 GOBIESOCIDAE, 106, 392, Plate
 40
 GOBIIDAE, 86, 388
Gobio fluviatilis, 288, Plate 116
gobio, *Cottus*, 46, Plate 7
Gobius capito, 90; *Friesii*, 93, Plate
 29; *Jeffreysii*, 95; *minutus*, 93;
niger, 91, Plate 42; *orca*, 97; *paga-*
nellus, 92, Plate 29; *pictus*, 95,
 Plate 30; *ruthensparri*, 94; *scor-*
pioides, 96, Plate 30
Gold-fish, 285
Goldsinny, 130
Gonostoma bathyphilum, 367, 379
 GONOSTOMATIDAE, 367, 379
gouanii, *Lepadogaster*, 107, Plate 40
gracilior, *Coregonus*, 241, 380
Graining, 294
grayi, *Salvelinus*, 238, 380
Grayling, 245, Plate 120
Greater flying fish, 251, Plate 105;
 forked beard, 160, Plate 61; pipe
 fish, 209, Plate 84; sand eel, 166,
 Plate 64; weever, 59, Plate 3
Greenbone, 249, Plate 102
Greenland halibut, 362; shark, 325,
 Plate 125
Grey gurnard, 52, Plate 17
Grey mullet, 122, Plate 50
Grilse, 222
griseus, *Notidanus*, 316, Plate 121
grohmanni, *Arnoglossus*, 205, 390
Gudgeon, 288, Plate 116
guentheri, *Lionurus*, 359, 383
gunnellus, *Pholis*, 114, Plate 49;
 eggs, Plate 48
Gurnard, grey, 52, Plate 17; red, 51,
 Plate 12; shining, 53; streaked,
 53, Plate 17; yellow, 50, Plate 13
Gurnards, 50
gurnardus, *Trigla*, 52, Plate 17
Gwyniad, 243, Plate 100
Haddock, 141, Plate 55
Haddy, 237
Hag, 348
Hair-tail, 85, Plate 33
Hake, 157, Plate 61; forked, 160,
 Plate 61
Halargyreus affinis, 358, 384
Halibut, 190, Plate 74
Hammer-headed shark, 308, 377
 HAPLOMI, 381
harengus, *Clupea*, 256, Plate 109;
 eggs, Plate 106
Hearing in fishes, 13
helena, *Muraena*, 275, 382
helgae, *Cyttosoma*, 356, 385
Helicolenus dactylopterus, 354, 389;
microphihalmus, 354, 389
Hemirhamphus, 250

- Henfish, 101, *Plates* 39-41; eggs, *Plate* 37
 Heptanchus, 316
 Herling, 230
 Herring, 256, *Plate* 109; eggs, *Plate* 106; scale, *Plate* 11
 HETEROMI, 372, 382
 HETEROSOMATA, 169, 361, 390
 HEXANCHIDAE, 376
Hexanchus griseus, 376
hibernicus, *Dolopichthys*, 355, 392
Hippocampus antiquorum, 210. *Plate* 84
Hippoglossoides limandoides, 191. *Plate* 75
hippoglossoides, Reinhardtii, 362, 391
Hippoglossus vulgaris, 190x *Plate* 74
hirundo, *Trigla*, 50. *Plate* 13
 HOLOCEPHALI, 378
Hoplostethus, 29, 353, 385
Hoplostethus atlanticus, 353, 385; *mediterraneus*, 353, 385
 Horned ray, 343, 378
 Horse mackerel, 78. *Plate* 25
 Houting, 244. *Plate* 104
 Humantin, 320
humboldti, *Myctophum*, 364, 381
 Humpback salmon, 216
 Hybridism, 10
 Hybrids, 10
 HYPEROARTIA, 376
 HYPEROTRETA, 376
 HYPOTREMATA, 374, 377

Imperialis, *Luvarus*, 75. *Plate* 24
infans, *Avocettina*, 371, 382
inimicus, *Dolopichthys*, 355, 392
 INIOMI, 362, 381
irideus, *Salmo*, 233. *Plate* 98
 ISOSPONDYLI, 365, 379
Istiophorus americanus, 356, 387
 ISTIOPHORIDAE, 356, 387

 Jack Sharp, 124
jeffreysii, *Gobius*, 95, 388
 Jerusalem haddock, 76
 John Dory, 82. *Plate* 31
julis, *Coris*, 131. *Plate* 52

Katsuwonus pelamis, 387
 Kelts, 218, 222
killinensis, *Salvelinus*, 237, 380
 King-fish, 76
 King of the herrings, 349. *Plate* 143
kiitt, *Microstomus*, 391

labiatus, *Coelorrhynchus*, 359, 383
labrax, Morone, 34. *Plate* 2
 LABRIDAE, 127, 386
Labrus bergylla, 128, *Plate* 52;
exoletus, 131; *mixtus*, 129, *Plate* 52; *palloni*, 130; *ruprestris*, 130
Laemargus microcephalus, 325. *Plate* 125
Laemonema latifrons, 357, 384
laevis, *Malacocephalus*, 359, 383;
Phoxinus, 290, *Plate* 107
laevis, *Rhombus*, 201. *Plate* 83
lagocephalus, *Tetrodon*, 211
Lamna cornubica, 311. *Plate* 129
 LAMNIDAE, 310, 376
Lampadena chavesi, 365, 381
Lampanyctus crocodilus, 364; *elongatus*, 364; *gemmifer*, 364
 Lampern, 345. *Plate* 136
Lampetra fluviatilis, 345; *planeri*, 347, *Plate* 136
lampetrisformis, *Lumpenus*, 113. *Plate* 49
 Lamprey, brook, 347, *Plate* 136;
 river, 346, *Plate* 136; sea, 344,
Plate 136
 LAMPRIDIDAE, 76, 384
Lampris luna, 76
Lamprotorus flagellibarba, 371, 379
lanceolatus, *Ammodytes*, 166. *Plate* 64
 Large-spotted dogfish, 318. *Plate* 131
lascaris, *Pegusa*, 391; *Solea*, 197,
Plate 79
 Lateral line, 15
laterna, *Arnoglossus*, 203. *Plate* 81
latifrons, *Anarhichas*, 357, 389
latifrons, *Laemonema*, 357, 384
latirostris, *Anguilla*, 268
lavaretus, *Coregonus*, 242. *Plate* 103
 Leather carp, 282
Leirus medusophagus, 72. *Plate* 23;
perciiformis, 70, *Plate* 27

- Lemon sole, 182. Plate 69
Lepadogaster bimaculatus, 107, Plate 40; *decanolii*, 107, Plate 40; *gouanii*, 107, Plate 40; *microcephalus*, 107, Plate 40
Lepidion eques, 358, 384
Lepidopus caudatus, 86. Plate 33
Lepidorhombus boschii, 361; *whiffiagonis*, 391
Leptocephalus brevisrostris, 270, 274; *morisii*, 270, 274
lepturus, *Trichiurus*, 85. Plate 33
Lesser Fork-beard, 162. Plate 62
Lesser spotted dogfish, 318, Plate 131; eggs, Plate 43
Lesser weever, 60. Plate 15
Leuciscus cephalus, 292, Plate 107; *leuciscus*, 294, Plate 107; *rutulus*, 295, Plate 123
levenensis, *Salmo*, 227
Lichia glauca, 80; *vadigo*, 80
limanda, *Pleuronectes*, 185. Plate 71
limandoides, *Hippoglossoides*, 191. Plate 75
lineata, *Trigla*, 53. Plate 17
lineatus, *Cantharus*, 41. Plate 5
Ling, blue, 156, Plate 59; common, 155, Plate 59; Mediterranean, 156
Lionurus aequalis, 359; *guentheri*, 359
LIPARIDAE, 390
liparis, *Cyclogaster*, 105, Plate 38; eggs, Plate 35
Loach, 303. Plate 116
Long-finned gurnard, 53; tunny, 65, Plate 20
longipinnis, *Brama*, 75
Long-nosed skate, 336
Long rough dab, 191. Plate 75
Long-spined sea scorpion, 48, Plate 8; eggs, Plate 37
LOPHIIDAE, 355, 392
Lophius piscatorius, 57. Plate 18
LOPHOBRANCHII, 357
Lota vulgaris, 161. Plate 60
lucerna, *Trigla*, 50. Plate 13
lucidus, *Alburnus*, 302. Plate 124
lucius, *Esox*, 253. Plates 95, 108
lumbriciformis, *Nerophis*, 208, 210. Plate 84
LUMPENIDAE, 113, 388
Lumpenus lampetrisformis, 113. Plate 49
Lump-sucker, 101, Plates 39, 41; eggs, Plate 37
lumpus, *Cyclopterus*, 101, Plates 39, 41; eggs, Plate 37
luna, *Lampris*, 76
lupus, *Anarrhichas*, 109, Plate 42; eggs, Plate 43
lupus, *Labrax*, 34, Plate 2; scales, Plate 11
luscus, *Gadus*, 148. Plate 54
lutea, *Solea*, 198. Plate 80
LUVARIDAE, 75, 387
Luvarus imperialis, 75, Plate 24
Lyconus brachycolus, 360, 383
lyra, *Callionymus*, 99. Plate 34
lyra, *Trigla*, 54. Plate 15
Macdonaldia rostrata, 372, 382
Mackerel, 62, Plate 21; Spanish, 63, Plate 16; food, Plate 68
macropterus, *Alepocephalus*, 367, 379
MACRORAMPHOSIDAE, 383
Macroramphosus scolopax, 383
MACRURIDAE, 30, 358, 383
macrorhynchus, *Raja*, 340. Plate 140
maculata, *Raja*, 339. Plate 138
maculatus, *Balistes*, 391; *Callionymus*, 100, Plate 36
Mahseer, 283
Malacocephalus laevis, 359, 383
malleus, *Zygaena*, 308
marginata, *Raja*, 378
Marine Biological Association, 30
marinus, *Petromyzon*, 344, Plate 136; *Sebastes*, 389
marmorata, *Torpedo*, 329. Plate 128
Mauroliscus muelleri, 368; *pennantii*, 214, 368
maxima, *Selache*, 314. Plate 122
maximus, *Cetorhinus*, 361
maximus, *Rhombus*, 200. Plate 77
Meagre, 84. Plate 32
mediterranea, *Mora*, 358, 384
mediterraneus, *Hoplostethus*, 353, 385
Mediterranean ling, 156
medusophagus, *Leirus*, 72

- megaceros*, *Dolopichthys*, 355, 392
megalops, *Melamphaes*, 353, 385
megastoma, *Arnoglossus*, 202. Plate 78
megastoma, *Lepidorhombus*, 202. Plate 78
 Megrim, 202. Plate 78
Melamphaes beanii, 353, 385; *megalops*, 353, 385
MELAMPHAIDAE, 353, 385
melanobranchus, *Bathygadus*, 359, 383
melanostomus, *Pristiurus*, 319. Plate 122
melops, *Crenilabrus*, 129. Plate 52
merlangus, *Gadus*, 150. Plate 57
MERLUCCIIDAE, 157, 383
Merluccius merluccius, 383 *vulgaris*, 157, Plate 61
 Merluce, 158
microcellata, *Raja*, 337. Plate 137
microcephalus, *Laemargus*, 325, Plate 125; *Lepadogaster*, 107, Plate 40; *Pleuronectes*, 182, Plate 69; *Somniosus*, 377
Microchirus boscanion, 391; *variegatus*, 391
microdon, *Cyclothone*, 367, 379
microphthalmus, *Helicolenus*, 354, 389
Microstomus kitt, 391
 Miller's thumb, 46. Plate 7
 Minnow, 290. Plate 107
minor, *Anarhichas*, 110
 Minute goby, 93
minutus, *Gadus*, 148, Plate 54; *Gobius*, 93
 Mirror-carp, 282
Misgurnus fossilis, 304
mixtus, *Labrus*, 129. Plate 52
Mobula giorna, 378
mola, *Orthogoriscus*, 212. Plate 85
MOLIDAE, 212, 392
Molva abyssorum, 30
Molva byrkjelange, 29, 156, Plate 59; *elongata*, 157; *molva*, 155, Plate 59; *vulgaris*, 155, Plate 59
 Monk fish, 328. Plate 127
monstrosa, *Chimaera*, 349. Plate 143
montagui, *Blennius*, 111, Plate 45; *Cyclogaster*, 105, Plate 38; *Raja*, 378
 Montagu's blenny, 111, Plate 45; sucker, 105, Plate 38; eggs, Plate 35
Mora mediterranea, 358, 384
Morone labrax, 34, Plate 2; scales, Plate 11
morrhua, *Gadus*, 134. Plate 55
morrisii, *Leptocephalus*, 270, 274
Motella cimbria, 163, Plate 58; *macrophiha*, 163, Plate 58; *mustela*, 163, Plate 63; *tricirrata*, 162, Plate 63
Mugil auratus, 123; *capito*, 123; *chelo*, 123, Plate 50; *septentrionalis*, 123
MUGILIDAE, 122, 389
 Mullet, grey, 122, Plate 50; red, 37, Plate 3
MULLIDAE, 37, 386
Mullus surmuletus, 37. Plate 3
Muraena helena, 275
MURAENIDAE, 275, 382
murinus, *Pristiurus*, 373, 377
murrayi, *Coryphaenoides*, 359, 383
murrayi, *Trachyrhynchus*, 360, 383
murrayi, *Triglops*, 54, 390
 Murry, 275
mustela, *Motella*, 163. Plate 63
Mustelus vulgaris, 309. Plate 118
MYCTOPHIDAE, 363, 381
Myctophum arcticum, 363; *glaciale*, 363; *humboldtii*, 364; *punctatum*, 364
MYLIOBATIDAE, 342, 378
Myliobatis aquila, 342, 378
Myxine glutinosa, 348, 376
MYXINIDAE, 343, 376
Naevus, *Raja*, 338
nasutus, *Nesiarchus*, 356, 387
Naucrates ductor, 79. Plate 27
Nemachilus barbatula, 305. Plate 116
Nematonurus farrani, 360, 383
NEMICHTHYIDAE, 371, 382
Nemichthys scolopaceus, 371, 382
Nerophis aequoreus, 209, Plate 84; *humbriciformis*, 210, Plate 84; *ophidion*, 209, Plate 84
Nesiarchus nasutus, 356, 387
Nettophichthys retropinnatus, 372, 382

- niger*, *Astronesthes*, 369; *Centrolophus*, 69, Plate 26; *Conger*, 273, Plate 112; *Gobius*, 91, Plate 42
nilssonii, *Crystalllogobius*, 98, 388
nobiliana, *Torpedo*, 329, 377
norvegicus, *Sebastes*, 43, Plate 4
 Norway haddock, 43, Plate 4; pout, 151, Plate 56
 NOTACANTHIDAE, 372, 382
Notacanthus bonapartii, 30, 372, 382
 NOTIDANIDAE, 316
Notidanus griseus, 316, Plate 121
 Nursehound, 318, Plate 131

 Oar-fish, 120, Plate 47
 Oblong sunfish, 212
obscura, *Trigla*, 53, 390
 Ocean pipe-fish, 208
ocellaris, *Blennius*, 111, Plate 44
 Old-wife, 41, Plate 5
Onchorhynchus gorbusha, 216; *keta*, 216; *kisutch*, 216; *tschawytscha*, 216; *nerka*, 216
 ONEIRODIDAE, 392
Onos cimbrius, 384; *mustelus*, 384; *tricirratu*, 384
 Opah, 76
 Operculum, 6
 OPHIDIIDAE, 167, 389
Ophidium barbatum, 168, Plate 64
ophidion, *Nerophis*, 208, Plate 84
 Orange fins, 230
Orcynus germs, 387; *thynnus*, 387
Orithagoriscus mola, 212, Plate 85; *truncatus*, 212
 OSMERIDAE, 380
Osmerus eperlanus, 247, Plate 92
 OSTARIOPHYSI, 381
owenii, *Sparus*, 42
Oxynotus centrina, 377; *paradoxus*, 373, 377
oxyrhynchus, *Coregonus*, 244, Plate 104; *Raja*, 336

Paganellus, *Gobius*, 92, Plate 29
 Pagellus, 40, Plate 9
Pagrus auratus, 41; *vulgaris*, 41
 Painted goby, 95, Plate 30
 Painted ray, 337, Plate 137

palloni, *Acantholabrus*, 130; *Labrus*, 130
Pammelas perciformis, 72, 389
 Pandora, 40, 42
Paralepis coregonoides, 215, 362, 381
 Parr, 219, Plate 88
Parviclinus spinosus, 357, 388
pastinaca, *Trygon*, 341, Plate 141
 Peal, 230
 Pearl-sides, 214
 PEDICULATI, 57, 355, 392
Pegusa lascaris, 391
 Pelagic fish, eggs, 89
 Pelamid, 66, Plate 16
pelamis, *Katsuwonus*, 387
Pelamys sarda, 66, Plate 16
pelamys, *Thynnus*, 66, 387
pellucida, *Aphya*, 97, 388
pennantii, *Coregonus*, 243, Plate 100; *Maurolicus*, 214
Perca fluviatilis, 33, 385, Plate 1
 Perch, 33, Plate 1; eggs, Plate 66
 PERCIDAE, 32, 353, 385
perciformis, *Leirus*, 70; *Pammelas*, 72, 389
 PERCOMORPHI, 353, 385
perisui, *Salvelinus*, 237, 380
Peristedion cataphractum, 390
Peristethus cataphractum, 57, 390
Petromyzon branchialis, 347; *fluviatilis*, 345, Plate 136; *marinus*, 344, Plate 136; *planeri*, 347, Plate 136
 PETROMYZONIDAE, 376
 Phinock, 227
 PHOLIDAE, 114, 388
Pholis gunnellus, 114, Plate 49; eggs, Plate 48
Phoxinus laevis, 290, Plate 107
Phrynorhombus norvegicus, 391; *regius*, 391
Phycis blennoides, 160, Plate 61
 Picked dogfish, 320, 321, Plate 131
pictus, *Gobius*, 95, Plate 30
 Pike, 253, Plates 95, 108
 Pilchard, 262, Plate 117
pilchardus, *Clupea*, 262, Plate 117
 Pilot-fish, 79, Plate 27
pini, *Trigla*, 51, Plate 12
 Pipe-fishes, 208, Plate 84
 Piper, 54, Plate 15
piscatorius, *Lophius*, 57, Plate 18

- Plaice, 171, *Plate 65*; eggs, *Plate 66*;
food, *Plate 67*; marked, *Plate 68*
Plain bonito, 67
planeri, *Petromyzon*, 347. *Plate 136*
Plankton, 9
platessa, *Pleuronectes*, 171, *Plate*
65; eggs, *Plate 66*; food, *Plate*
67; marked, *Plate 68*
Platichthys flesus, 391
PLECTOGNATHI, 391
Pleuronectes cynoglossus, 184, *Plate*
70; *flesus*, 187, *Plate 72*; eggs,
Plate 73; food, *Plate 67*; *limanda*,
185, *Plate 71*; *microcephalus*, 182,
Plate 69; *platessa*, 171, *Plate 65*;
eggs, *Plate 66*
PLEURONECTIDAE, 362, 391
PLEUROTREMATA, 373, 376
Pneumatophorus colias, 387
Pogge, 55. *Plate 25*
pollachius, *Gadus*, 152. *Plate 57*
Pollock, 152. *Plate 57*
Pollan, 241. *Plate 103*
pollan, *Coregonus*, 241, *Plate 103*;
Lough Erne, 242; Shannon, 242
Polyipnus spinosus, 369, 379
Polyprion americanus, 36; *cernium*, 36
Poor-cod, 148. *Plate 54*
Pope, 34. *Plate 1*
Porbeagle, 311. *Plate 129*
Pout, 148, *Plate 54*; Norway, 151,
Plate 56
Poutassou, 153. *Plate 56*
poutassou, *Gadus*, 153. *Plate 56*
Powan, 242. *Plate 103*
presbyter, *Atherina*, 121. *Plate 51*
pretiosus, *Ruvettius*, 355, 387
Pride, 347. *Plate 136*
Pristis antiquorum, 330
Pristiurus melanostomus, 319, *Plate*
122; *murinus*, 373, 377
profundicola, *Bathysolea*, 362, 391
Prussian carp, 284. *Plate 114*
Psettodes, 3
punctatum, *Myctophum*, 364, 381
punctatus, *Zeugopterus*, 30, 205.
Plate 82
pungitius, *Gasterosteus*, 125, *Plate 7*;
Pygosteus, 390
Pygosteus pungitius, 390
Pyloric appendages, 5
Quadricornis, *Cottus*, 49. *Plate 50*
Quinnat, 216
Rabbit fish, 349. *Plate 143*
radiata, *Raja*, 339. *Plate 139*
rafinesquei, *Diaphus*, 364, 381
Rainbow trout, 233, *Plate 98*;
wrasse, 131, *Plate 52*
Raja alba, 335, *Plate 130*; *batis*, 334,
Plate 133; *circularis*, 337, *Plate*
135; *clavata*, 338, *Plate 134*; *ful-*
lonica, 337, *Plate 132*; *macro-*
rhynchus, 340, *Plate 140*; *maculata*,
339, *Plate 138*; *marginata*, 362;
microcellata, 337, *Plate 137*; *mir-*
letus, 338; *naevus*, 338; *oxy-*
rhynchus, 336; *picta*, 362; *radiata*,
339, *Plate 139*; *undulata*, 340
ravi, *Brama*, 74. *Plate 22*
Rainbow wrasse, 131. *Plate 52*
RAJIDAE, 330, 375, 378
Raniceps raninus, 162. *Plate 62*
Ranzania truncata, 392
Ray, bottle-nose, 335, *Plate 130*;
cuckoo, 337, *Plate 135*; eagle,
342; electric, 328, *Plate 128*;
horned, 343; painted, 337, *Plate*
137; sandy, 338; shagreen, 337,
Plate 132; spotted, 339, *Plate*
138; starry, 339, *Plate 139*;
sting, 341, *Plate 141*; thornback,
338, *Plate 134*; undulate, 340
Ray's bream, 74. *Plate 22*
Red band-fish, 117. *Plate 46*
Red gurnard, 51. *Plate 12*
Red mullet, 37. *Plate 3*
Regalecus glesne, 120. *Plate 47*
Reinhardtius hippoglossoides, 362, 391
remora, *Echeneis*, 68. *Plate 24*
retropinnatus, *Nettophichthys*, 372,
382
Reversed fish, 3
Rhamphistoma belone, 249. *Plate 102*
Rhina squatina, 328. *Plate 127*
RHINIDAE, 328
Rhinochimaera atlantica, 375, 378
Rhombus laevis, 201, *Plate 83*;
maximus, 200, *Plate 77*
Ribbon-fish, 120. *Plate 47*
Roach, 295, *Plate 123*; eggs, *Plate 66*

- Roccus labrax*, 34. Plate 2
rochei, Auxis, 67
 Rock-cook, 131
 Rock goby, 92. Plate 29
 Rocklings, 162, 163. Plates 63, 58
rostrata, *Macdonaldia*, 372, 382
rostratus, *Alepocephalus*, 366; *Bathytroctes*, 367
rubescens, *Cepola*, 117. Plate 46
 Rudd, 297. Plate 123
 Rudderfish, 71
 Ruffe, 34. Plate 1
ruprestris, *Ctenolabrus*, 130; *Coryphaenoides*, 30, 359; *Labrus*, 130
ruthensparri, *Gobius*, 94
rutilus, *Leuciscus*, 295, Plate 123;
Rutilus, 295, Plate 123
Ruvettus pretiosus, 355, 387
- Saithe, 149. Plate 58
salar, *Salmo*, 215, Plates 88, 89, 90, 91, 92; scales, Plates 91, 101
Salmo irideus, 223, Plate 98; *salar*, 215, Plates 88, 89, 90, 91, 92; *Salmo Fario*, Plates 94, 95, 96, 97; *trutta*, 227, Plate 93
 Salmon, 215, Plates 88, 89, 90, 91, 92; eggs, Plate 66
 SALMONIDAE, 215, 380
Salvelinus colli, 238; *fimbriatus*, 239; *fontinalis*, 231, Plate 98; *gracillimus*, 238; *grayii*, 238; *infra-mundus*, 238; *killinensis*, 237; *lonsdalii*, 237; *mallochii*, 238; *maxillaris*, 238; *obtusius*, 239; *perisii*, 237; *scharfii*, 239; *struanensis*, 237; *trevellian*, 239; *willoughbii*, 236
salviani, *Centrina*, 320
 Sand eel, greater, 165, Plate 64; lesser, 166, Plate 64; eggs, Plate 106
 Sand smelt, 121, Plate 51; Boyer's, 121
 Sandy ray, 338
Saprolegnia ferax, 225
sarda, *Pelamys*, 66. Plate 16
Sardina pilchardus, 262, 379. Plate 117
 Sardine, 262. Plate 117
saurus, *Scomberox*, 250. Plate 102
- Saury pike, 250. Plate 102
 Saw fish, 330
 Scabbard fish, 86. Plate 33
scabrus, *Trachyrhynchus*, 30
 Scald-fish, 203. Plate 81
 Scale-rayed wrasse, 130
 Scale-readings, 14
Scardinius erythrophthalmus, 297. Plate 123
 Schelly, 243
Sciaena aquila, 84. Plate 32
 SCIAENIDAE, 84, 386
 SCLEROPAREI, 389
scolopax, *Centriscus*, 126; *Macroramphosus*, 383
scolopaceus, *Nemichthys*, 371, 382
Scomber colias, 63, Plate 16; *scombrus*, 61, 62, Plate 21
 SCOMBERESOCIDAE, 250, 382
Scomberesox saurus, 250. Plate 102
 SCOMBRIDAE, 61, 387
scombrus, 62
 SCOPELIDAE, 214, 362
Scophthalmus maximus, 391; *rhombus*, 391
 SCORPAENIDAE, 43, 354, 389
Scorpaena cristulata, 354, 389; *scrofa*, 354, 389; *dactyloptera*, 44, 389
 Scorpion goby, 96. Plate 30
scorpius, *Cottus*, 47, Plate 10; eggs, Plate 48
 Scottish Fishery Board, 31
scrofa, *Scorpaena*, 354, 389
 SCYLIORHINIDAE, 373, 377
Scyliorhinus caniculus, 377
Scyliorhinus stellaris, 377
 SCYLLIDAE, 317
Scyllium canicula, 318, Plate 131; *catulus*, 318, Plate 131
Scymnodon ringens, 374, 377
Scymnorhinus lichia, 316
 Sea bream, 40; common, 40, Plate 9; Spanish, 40, 42
 Sea horse, 210. Plate 84
 Sea lamprey, 344. Plate 136
 Sea trout, 227. Plate 93
Sebastes marinus, 43, 389; *norvegicus*, 43, 389; *viviparus*, 354, 389. Plate 4
 Secondary sexual characters, 8
Selache maxima, 314, 376. Plate 122
Septentrionalis, *Mugil*, 123

- SERRANIDAE**, 35, 385
Serranus cabrilla, 35, Plate 6; *gigas*, 35
Serrivomer beani, 371, 382
SERRIVOMERIDAE, 371, 382
 Sewen, 227, 229
 Shagreen ray, 337. Plate 132
 Shanny, 112. Plate 45
 Sharp-nosed eel, 268
 Shining gurnard, 53
 Short-finned tunny, 66
 Short-spined sea scorpion, 47, Plate 10; eggs, Plate 48
 Sight in fishes, 13
silus, Argentina, 248
 Silvery pout, 154
Siphonostoma typhle, 208. Plate 84
 Six-gilled shark, 316. Plate 121
 Skate, bottled-nose, 335, Plate 130; common, 334, Plate 133; flapper, 340, Plate 140; long-nosed, 336
 Small spotted dogfish, 318. Plate 131
 Smelt, 247. Plate 92
 Smolt, 220
 Smooth hound, 309. Plate 118
socialis, *Xenodermichthys*, 367, 379
Solea azevia, 194; *lascaris*, 197, Plate 79; *lutea*, 198, Plate 80; *variegata*, 198, Plate 80; *vulgaris*, 195, Plate 76
 Sole, common, 195, Plate 76; French, 197, Plate 79
SOLEIDAE, 362, 391
 Solenette, 198. Plate 80
SOLENICHTHYES, 383
 Sole, thickback, 198. Plate 80
Somniosus microcephalus, 377
 Sordid dragonet, 99
 Spanish bream, 40, 42
 Spanish mackerel, 63. Plate 16
SPARIDAE, 39, 386
 Sparling, 247. Plate 92
Sparus bogaroveo, 42; *centrodontus*, 40, Plate 9; *erythrinus*, 42; *owenii*, 42
sphyræna, Argentina, 248. Plate 26
Sphyrna xygaena, 377
spinachia, *Gasterosteus*, 125. Plate 36
 Spinacidae, 319, 373
Spinax niger, 324; *spinax*, 377
 Spined loach, 305. Plate 116
spinosus, *Echinorhinus*, 327, Plate 125; *Parviclinus*, 357; *Polyipnus*, 369, 379
 Spinous shark, 327. Plate 125
splendens, *Beryx*, 352, 385
Spondylisoma cantharus, 386
 Spotted goby, 94
 Spotted ray, 339. Plate 138
 Sprat, 261. Plate 117
sprattus, *Clupea*, 261. Plate 117
SQUALIDAE, 373, 377
Squalius cephalus, 381
Squalus acanthias, 377
squatina, *Rhina*, 328. Plate 127
SQUATINIDAE, 377
 Starry-ray, 339. Plate 139
stellaris, *Sailliorhinus*, 377
STERNOPTYCHIIDAE, 368, 379
Sternoptyx diaphana, 368, 379
 Sticklebacks, 124, 125. Plate 7
 Sting-fish, 60. Plate 15
 Sting-ray, 341. Plate 141
Stomias boa, 370, 379
STOMIATIDAE, 370, 379
 Stone-bass, 36. Plate 2
 Steaked gurnard, 53. Plate 17
 Straight-nosed pipe-fish, 209. Plate 84
 Stripe-bellied tunny, 66
STROMATEIDAE, 68, 389
struanensis, *Salvelinus*, 237
 Sturgeon, 305. Plate 108
sturio, *Acipenser*, 305. Plate 108
 Suckers, Connemara, 106, Plate 40; Cornish, 106, Plate 40; double-spotted, 106, Plate 40; small-headed, 106
SUDIDAE, 362, 381
 Sun-fish, 212. Plate 85
surmuletus, *Mullus*, 37. Plate 3
 Sword-fish, 83. Plate 28
SYGNATHIDAE, 208, 362, 383
Syngnathus acus, 208, Plate 84; *rostellatus*, 362
SYNAPHOBRANCHIDAE, 372, 382
Synaphobranchus pinnatus, 276, 382
SYNENTOGNATHI, 382
Taenia, *Cobitis*, 305. Plate 116
telescopus, *Epigonus*, 354, 385
 Temperature of fish, 5
 Tench, 289. Plate 119

- Ten-spined stickleback, 125. *Plate 7*
Tetrodon lagocephalus, 211
TETRADONTIDAE, 211, 392
 Thickback sole, 198. *Plate 80*
thomsonii, *Cottunculus*, 355, 390
 Thornback ray, 338, *Plate 134*; egg
 capsule, 332, *Plate 14*
 Thresher, 313. *Plate 121*
 Three-bearded rockling, 162. *Plate 63*
 Three-spined stickleback, 124. *Plate 7*
 Thunnus thynnus, 64. *Plate 19*
Thymallus vulgaris, 245, *Plate 120*; scale, *Plate 101*
Thynnus germon, 65, *Plate 20*
Tinca vulgaris, 289. *Plate 119*
tobianus, *Ammodytes*, 166. *Plate 64*
 Tope, 308. *Plate 129*
 Topknot, Bloch's, 206, *Plate 81*; common, 205, *Plate 82*; Ekstrom's, 391; Norwegian, 207
tor, *Barbus*, 283
 Torgoch, 237
TORPEDINIDAE, 328, 374, 377
Torpedo marmorata, 329, *Plate 128*; *nobiliana*, 329; *torpedo*, 374, 377
 Torsk, 164. *Plate 62*
TRACHICHTHYIDAE, 353, 385
TRACHINIDAE, 59, 387
Trachinotus glaucus, 386
Trachinus draco, 59, *Plate 3*; *viper*, 60, *Plate 15*
trachurus, *Caranx*, 78. *Plate 25*
TRACHYPTERIDAE, 118, 384
Trachypterus arcticus, 118. *Plate 47*
Trachyrhynchus murrayi, 360; *sca-brus*, 30
 Trawling, 29
TRICHIURIDAE, 85, 387
Trichiurus lepturus, 85. *Plate 33*
tricirrata, *Motella*, 162. *Plate 63*
tricirratus, *Onos*, 384
 Trigger fish, 210. *Plate 86*
Trigla gurnardus, 52, *Plate 17*; *hirundo*, 50, *Plate 13*; *lineata*, 53, *Plate 17*; *lucerna*, 50, *Plate 13*; *lyra*, 54, *Plate 15*; *obscura*, 53; *pini*, 51, *Plate 12*
TRIGLIDAE, 50, 390
Triglops murrayi, 54, 390
tripunctulatus, *Valenciennellus*, 368, 379
 Trout, 227. *Plates 93, 94, 95, 96, 97, 98*
 Truff, 230
 Trumpet fish, 126
truncata, *Ranzania*, 392
truncatus, *Orthogoriscus*, 212
trutia, *Salmo*, 227. *Plates 93, 94, 95, 96, 97*
TRYGONIDAE, 378
Trygon pastinaca, 341. *Plate 141*
 Tub-fish, 50. *Plate 13*
 Tunny, 64. *Plate 19*
 Turbot, 200. *Plate 77*
 Tusk, 164. *Plate 62*
 Twaite-shad, 264. *Plate 104*
typhle, *Siphonostoma*, 208. *Plate 84*
Unimaculatus, *Zeugopterus*, 206. *Plate 81*
Urophycis blennoides, 384; *chuss*, 358, 384
 Vaagmar, 118. *Plate 47*
vadigo, *Lichia*, 80
Valenciennellus tripunctulatus, 368, 379
vandesius, *Coregonus*, 240. *Plate 100*
variegata, *Solea*, 198. *Plate 80*
 Variegated sole, 198. *Plate 80*
variegatus, *Microchirus*, 391
 Vendace, 240; Cumberland, 241; Lochnaben, 240, *Plate 100*
viola, *Antimora*, 358, 384
vipera, *Trachinus*, 60. *Plate 15*
virens, *Gadus*, 149. *Plate 58*
 Vision, 12
 Viviparous blenny, 115. *Plate 46*
viviparus *Sebastes*, 354, 389; *Zoarces*, 115, *Plate 46*
volitans, *Exocoetus*, 251. *Plate 105*
vulgaris, *Acanthias*, 320, 321, *Plate 131*; *Anguilla*, 267, *Plate 111*; *Belone*, 249, *Plate 102*; *Carassius*, 284, *Plate 114*; *Conger*, 273, *Plate 112*; *Dentex*, 36; *Galeus*, 308, *Plate 129*; *Molva*, 155, *Plate 59*; *Mustelus*, 309, *Plate 118*; *Pagrus*, 41; *Solea*, 195, *Plate 76*; *Thymallus*, 245, *Plate 120*; scale, *Plate 101*; *Tinca*, 289, *Plate 119*
vulpes, *Alopias*, 313. *Plate 121*

- Weever, greater, 59, *Plate 3*; lesser, 60, *Plate 15*
whiff-iaonis, *Lepidorhombus*, 391
 Whitebait, 29
 Whitefish, 239, 240, 244, 278
 Whiting, 150, *Plate 57*; Lough Neagh, 239
 Willoughby's char, 236
willoughbi, *Salvelinus*, 236
 Witch, 184. *Plate 70*
 Worm pipe-fish, 210. *Plate 84*
 Wrasse, ballan, 128, *Plate 52*; cork-wing, 129, *Plate 52*; cuckoo, 129, *Plate 52*; rainbow, 131, *Plate 52*; scale-rayed, 130
Xiphias gladius, 83. *Plate 28*
Xenodermichthys socialis, 364, 379
- XENOPTERYGI, 392
 XIPHIIDAE, 83, 387
Yarrella blackfordi, 368, 379
 Yarrell's Blenny; 112. *Plates 45, 49*
 Yellow Gurnard, 50. *Plate 13*
 ZEIDAE, 82, 356, 385
 ZEOMORPHI, 356, 385
Zengopterus norvegicus, 207; *punctatus*, 30, 205, *Plate 82*; *unimaculatus*, 206, *Plate 81*
Zeus faber, 82. *Plate 31*
Zoarcas viviparus, 115. *Plate 46*
 ZOARCIDAE, 115, 388
Zygaena malleus, 308

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